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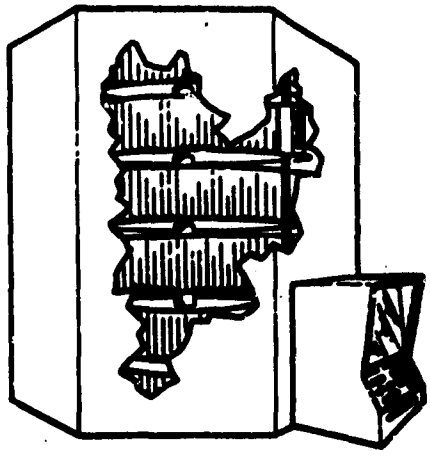
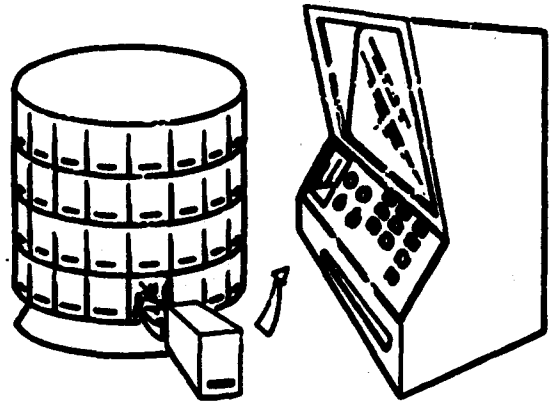
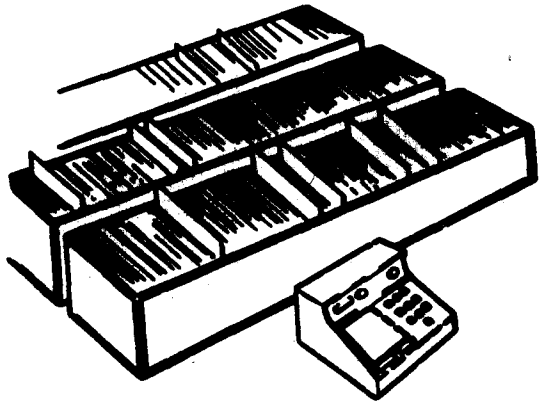




MICROFICHE STORAGE AND RETRIEVAL SYSTEM STUDY:

FINAL REPORT

AUGUST 1970



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BY
SYSTEM DEVELOPMENT CORPORATION
FALLS CHURCH, VA.

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TECHNICAL MEMORANDUM

(TM Series)

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MICROFICHE STORAGE AND RETRIEVAL SYSTEM STUDY:

FINAL REPORT

By:

Roger Wicker
Roy Neperud
Arthur Teplitz

10 August 1970

SYSTEM DEVELOPMENT CORPORATION
5720 COLUMBIA PIKE
FALLS CHURCH
VIRGINIA
22041

WASHINGTON OPERATIONS CENTER
CORPORATE OFFICES: Santa Monica, California

PREFACE

This report culminates a six-month study effort the primary objective of which was to develop design specifications for a microfiche storage and retrieval device applicable to the special needs of small libraries and research groups. To date, this group of microfiche users has been largely ignored by designers and manufacturers of storage and retrieval systems, even though this group of users grows increasingly larger.

The study was performed to provide an equipment design which would fulfill the microfiche storage and retrieval requirements of this specific small-user group. Consequently, the design development phase was preceded by a comprehensive survey of the small-user population to examine its microfiche handling practices and to evaluate its specific needs for equipment. The result is a recommendation which describes in detail equipment suitable for use by small-users. Design specifications are provided in this report for two storage and retrieval systems, each applicable to a specific user category. The specifications are sufficiently detailed to permit initiation of engineering analysis and generation of engineering drawings for the construction of prototype systems.

SDC wishes to thank the many people and organizations who assisted the study team in the performance of this effort. The willing cooperation of interviewees at the fifty libraries and research facilities visited is greatly appreciated, as is the advice and assistance rendered by the many manufacturers contacted during the course of the data collection.

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PART I

INTRODUCTION AND SUMMARY

1.0 PURPOSE AND SCOPE

This document contains the report of the activities and findings of a study conducted for the Defense Documentation Center (DDC) by System Development Corporation. The objective of the study was to determine user requirements and develop design objectives and specifications for a low-cost microfiche storage and retrieval system. Contained herein are data, analysis and conclusions pertaining to small user storage and retrieval requirements, the small user market, microfiche storage state-of-the-art, current research in microfiche storage and retrieval, and design objectives and specifications for two optimum storage and retrieval devices.

2.0 STUDY METHODOLOGY

The study was conducted over a six month period. Five specific tasks were performed. They were:

a. A survey of fifty small DDC users to determine the requirements of small users for microfiche storage and retrieval systems.

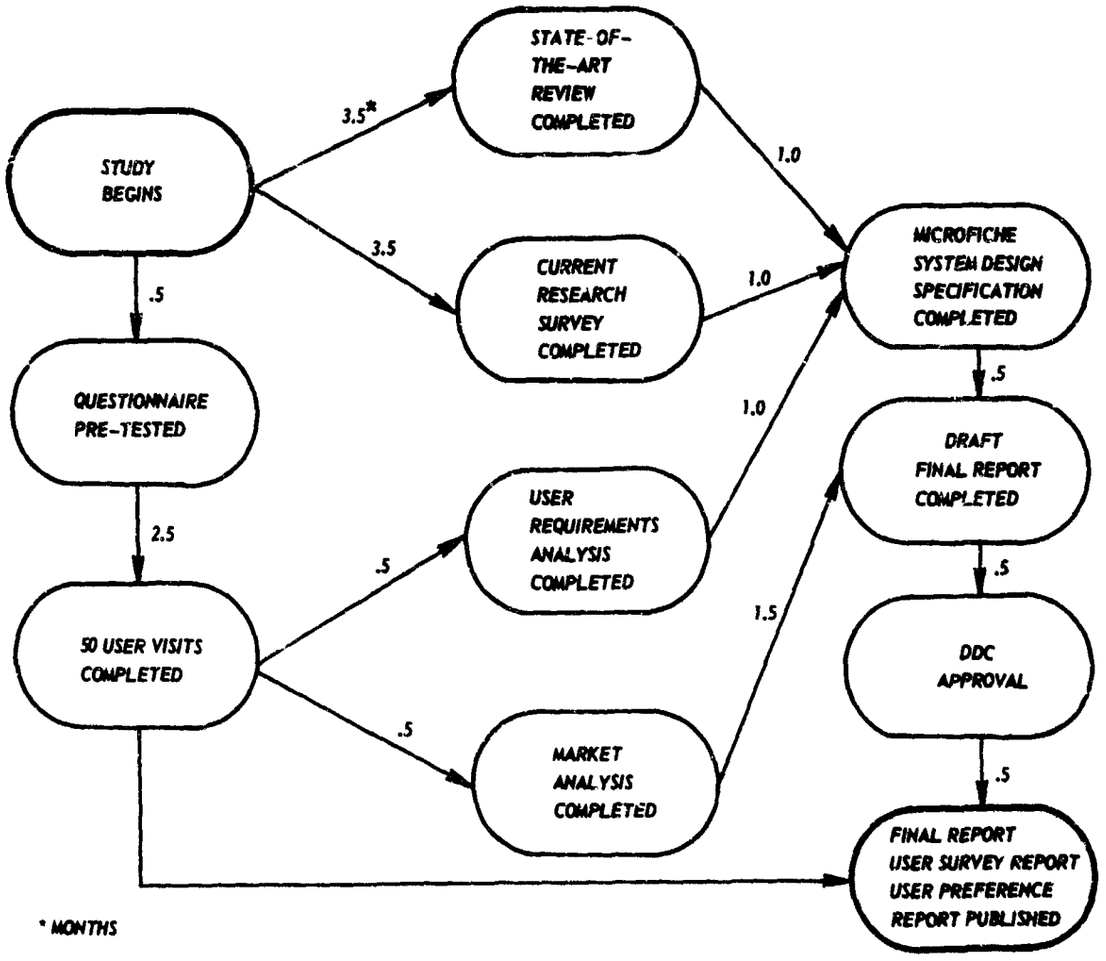
b. A survey of the user market as represented by the fifty selected DDC users.

c. Examination of present and projected state-of-the-art of microfiche storage and retrieval equipment.

d. Identification and description of current research in the area of microform storage and retrieval technology that might negate present development efforts.

e. Development of design objectives and specifications for a low-cost microfiche storage and retrieval system appropriate for use by small DoD field installations.

Each task was performed in accordance with a time-phased plan developed during the pre-contract period. The specific task performance sequence for the six-month period is described in the diagram below.



During the first two weeks of the study, an interview questionnaire was developed for use during the visits to the fifty selected DDC users (see Appendix B). The questionnaire was tested at two DDC user locations, the Naval Ordnance Laboratory Library at Silver Springs, Maryland and the Naval Propellent Plant Technical Library at Indian Head, Maryland. The questionnaire pre-test isolated questionnaire redundancies and omissions and enabled appropriate revisions to be made prior to the bulk of the user interviews.

During the two and one-half month period following the questionnaire pretest, fifty (50) small users of DDC microfiche materials were visited and interviewed (see Appendix A). Each visit was preceded by coordination between the SDC study team and the visited facility to insure maximum visit effectiveness. Advance coordination included, at a minimum, a telephone call and an advance copy of the interview questionnaire. During each visit, a member of the SDC study team examined the physical and functional organization and operation of the user's microfiche handling system, interviewed on-site personnel and collected other data, as required.

Data collected during the user visits were thoroughly analyzed to identify specific requirements of microfiche systems for DDC users with small, growing microfiche collections. Three distinct user types were identified. System requirements were described for several categories of users. System design constraints were also described. Findings and conclusions relevant to user requirements are documented in this report.

Following the completion of the user visits, the SDC study team analyzed collected data to determine the quantitative needs of small DoD installations for microfiche storage and retrieval systems in order to estimate the potential market for this type of equipment. This analysis included consideration of equipment needs as they relate to increase utilization of microfiche in the future. The market analysis is documented and has been included in this final report.

The SDC study team also examined present and projected microfiche storage and retrieval state-of-the-art. The review focused on equipment capabilities as they relate to present and future requirements of small DDC field activities. Review techniques included a literature search, evaluation of equipment presently on the market and contact with professionals active in microfiche systems and information sciences. The state-of-the-art of microfiche technology as it relates to the objectives of this study has been documented and is included in this final report.

SDC identified and described current research into microform storage and retrieval systems that might negate present system plans or equipment development activities. Data were gathered from manufacturers, technical literature and professional contacts. This survey focused on those research activities which appeared to have relevance to the objectives of this study and which required consideration in the selection of alternative system designs. The current research survey is documented in this final report.

Upon the completion of the above activities, the SDC study team integrated the conclusions of the user requirements, state-of-the-art, and current research analyses and developed a set of alternative microfiche system designs. Emphasis was placed on meeting the present requirements of a small, growing DoD field activity at an estimated cost of $3,000 to $4,000. Alternative designs were analyzed and two optimum designs selected, one for each of two user groups. Detailed design specifications were then prepared. Design objectives and specifications for both systems are documented in this final report.

3.0 SUMMARY

SDC's exploration of microform state-of-the-art and current research during the course of this study reveals developments which will be applicable to the requirements of many small DoD users and similar facilities in the next two to five years. The study's survey of the small user population reveals a variety of user types, each with differing microfiche storage and retrieval needs. At present, the needs of the typical small user are being met by manual storage and retrieval techniques. However, it is anticipated that as microfiche increasingly replaces hard copy and as equipment innovations continue to make the medium more attractive to users, the need and demand for more convenient storage and retrieval equipment will grow rapidly. In this regard, much depends on the quality of innovation by industry and on the quality of microfiche management at the user level.

SDC has documented design objectives and specifications for two microfiche storage and retrieval devices appropriate to the storage and retrieval requirements for two categories of DDC users. One is a relatively low-cost system utilizing cartridges for storing and handling of microfiche. This system is recommended primarily for small users with active collections under 10,000 in size. The second system is a fully automated, modular system which provides for on-line operation of a variety of output devices including reader-printers, duplicators and remote terminals. This system is recommended primarily for users with active collections up to 30,000 in size.

PART II

DDC/DOD SMALL USER REQUIREMENTS FOR MICROFICHE

STORAGE AND RETRIEVAL SYSTEMS

1.0 INTRODUCTION AND SUMMARY

This part of the final report summarizes the findings of the field survey of 50 small DDC microfiche users. The coverage is a synthesis of the requirements of those users; data are also included on their attitudes, preferences, and operating practices and experiences because these data constitute valuable background information in specifying the design of a low-cost microfiche storage and retrieval system.

User requirements are defined to constitute the combination of personnel, procedures, and equipment needed to satisfy a prescribed set of microfiche-handling functions. The requirements are conditioned by such factors as present and projected file sizes, usage rates, response time, and the number and physical dispersion of the information seekers. The principal constraints on meeting the requirements are personnel and equipment costs, personnel availability and training, and space.

The organization of this part of the report is as follows: (1) a discussion of the scope of the microform collections considered in the study; (2) a user statistical summary; (3) descriptions and microfiche system requirements of the users surveyed, by category; (4) a brief listing of user attitudes and preferences; and (5) as a by-product of the study, a description of additional or modified DDC services recommended for exploration.

The survey sample showed that there is little correlation between the size and nature of the users' microfiche-handling operations and their categorization, by DDC, as small DDC microfiche users. One-man and small RDT&E user groups were found; order-desk operations were found; and large-, medium-, and small-scale technical libraries and information centers were found in the sample.

Some one-man users presently order and maintain larger microfiche collections than do some technical libraries. Some users whose DDC/CFSTI microfiche collections are small have large non-DDC/CFSTI microfiche collections. No direct relationship was found between the size and present activity of a given user's collection--a one-man user may currently access his small personal collection with greater frequency than does a large-scale library maintaining several thousand microfiche. Finally, the users surveyed were found to vary widely in their experience, aggressiveness, sophistication, and attitude in conducting microfiche operations. The overall situation is fluid, and this prevailing environment is the context in which the information that follows should be viewed.

2.0 MICROFORM COLLECTIONS INCLUDED IN THE STUDY

The study is confined to technical reports, scientific and technical journal articles, and similar documentary items distributed in microfiche form. (Hereafter, in this part of the report, the terminology "technical reports" will be used.) Many users were found to also maintain extensive aperture-card files of engineering drawings and roll-film and/or microfiche collections of product specifications and standards, some of which are obtained from commercial sources as ready-made system packages; such holdings are independent of the users' technical-report collections, involve a different set of user requirements, and are not considered in this microfiche study.

However, in assessing user requirements, the users' total microfiche holdings of technical reports have been taken into account, not just their DDC/CFSTI holdings. A number of users have substantial microfiche collections derived from other sources. One user, for example, is presently ordering DDC/CFSTI microfiche at the rate of about 300 per year. But his total technical-report microfiche collection is growing at the rate of about 5,000 per year. Obviously, it would be grossly inaccurate to base that user's microfiche system requirements solely on his DDC/CFSTI holdings.

3.0 USER STATISTICAL SUMMARY

Quantitative data on order rates, present and projected microfiche collection sizes, and retrieval rates of the 50 users surveyed are shown in Table 1. The user identification numbers are arbitrarily assigned.

Some of the data shown in Table 1 are not self-explanatory. Blanks in the collection-size columns indicate that those users act as order desks only and maintain no collection. For some users, the present collection size shown is smaller than the number of microfiche ordered; the reasons are that the users weed out some of the microfiche and disperse some to other users instead of keeping all of the microfiche in a central collection. Numbers shown in parentheses are SDC, not user estimates; some users declined to project the sizes of their collections into the future because of the newness or fluidity of their microfiche and other document-handling operations. SDC's estimates are based on current ordering rates and the user's opinion as to whether he expects his order rate to increase, decrease, or remain about the same. Overall, the projected collection sizes should be regarded as speculative because the users' habits, attitudes, and needs are bound to be strongly influenced by many factors: changes in microform technology, DDC service policies, experience gained in using microfiche, user missions, and user policies for weeding collections. The volatility of the field makes firm projections a risky undertaking.

As Table 1 shows, the spread between the smallest and largest collections is exceedingly large--from 100 to 90,000. The spread between retrieval rates is also large--from 0 (some users have inactive collections) to 120 retrievals per day. Nine of the fifty users fall outside DDC's guidance, for the study, as to who constitutes a <u>small</u> DDC microfiche user--a user who orders DDC microfiche at the rate of 200-1000 ±50 microfiche per year. Users below and above those limits are separated from the remaining forty-one by heavy bar lines in the table. Also, as pointed out earlier, the DDC microfiche order rate is not very significant, in some instances, because of the preponderance of

USER TYPE	NUMBER OF DDC FICHE ORDERED CY'69	CENTRAL FILE SIZE (1970)	ESTIMATED FILE SIZE (1972)	ESTIMATED FILE SIZE (1975)	PRESENT DAILY RETRIEVAL RATE
1 (C)	66	-	-	-	-
2 (C)	123	-	-	-	-
3 (A)	153	(750)		(1,500)	Unknown
4 (B)	156	(600)		(1,200)	<1
5 (A)	181	33,500	38,500	42.000	<1
6 (B)	240	100	(500)	(700)	0
7 (A)	243	100	500	1,000	1
8 (A)	252	2,400	4,000	6,500	2
9 (A)	253	20,000	(22,500)	(26,000)	3
10(A)	295	200	(900)	(2,000)	Unknown
11(B)	298	400	(2,000)	(5,000)	2
12(A)	310	2,000	4,500	7,500	3
13(A)	316	10,000	20,000	35,000	10
14(B)	338	500	(900)	(1,600)	1
15(A)	341	800	1,500	3,000	0
16(C)	360	-	-	-	-
17(B)	360	400	700	1,000	<1
18(A)	375	400	(650)	(1,000)	Unknown
19(C)	396	-	-	-	-
20(C)	462	-	-	-	-
21(C)	486	-	-	-	-
22(A)	516	2,000	3,000	5,000	2
23(A)	520	2,000	4,500	10,000	2
24(B)	531	600	1,000	1,500	2
25(A)	532	450	1,000	(1,200)	0

USER TYPE: (A) Library/Info Center, (B) Bench-Level, (C) Order Desk

Table 2-1, User Statistical Summary (continued next page)

USER TYPE	NUMBER OF DDC FICHE ORDERED CY'69	CENTRAL FILE SIZE (1970)	ESTIMATED FILE SIZE (1972)	ESTIMATE FILE SIZE (1975)	PRESENT DAILY RETRIEVAL RATE
26(B)	574	400	600	600	2
27(B)	581	900	2,000	3,400	7
28(A)	582	650	2,000	5,000	2
29(B)	594	600	1,600	4,000	2
30(C)	602	-	-	-	-
31(B)	635	1,000	1,600	2,500	3
32(C)	640	-	-	-	-
33(A)	642	600	5,000	8,000	5
34(A)	667	630	(2,500)	(5,000)	1
35(A)	733	400	3,000	7,000	Unknown
36(B)	749	200	400	1,000	2
37(C)	768	-	-	-	-
38(A)	774	1,100	1,500	2,000	2
39(C)	822	-	-	-	-
40(A)	971	22,000	34,000	(70,000)	10
41(A)	988	35,000	40,000	47,000	Unknown
42(A)	1047	3,000	5,000	7,500	30
43(A)	1047	700	(820)	(940)	Unknown
44(B)	2141	7,000	9,400	12,000	Unknown
45(A)	2415	7,000	9,400	13,000	0
46(A)	2811	10,000	(13,600)	19,000	Unknown
47(A)	3895	7,300	19,000	28,000	1
48(A)	4696	10,000	(25,000)	(48,000)	25
49(A)	7959	90,000	(120,000)	(160,000)	120
50(A)	11491	15,000	(17,000)	(18,000)	25

USER TYPE: (A) Library/Info Center, (B) Bench-Level, (C) Order Desk

Table 2-1, User Statistical Summary (continued previous page)

non-DDC/CFSTI microfiche in some collections.

Of the forty-one users who meet DDC's criterion as small users, eight function solely as order desks and maintain no collection. Data presented in the balance of this part of the report pertain to the thirty-three users who meet the criterion, unless otherwise stated. A statistical profile of these thirty-three users is presented in Table 2. Figures shown are rounded to the nearest 100. The five largest users in this group (see Table 1) have a disproportionate effect on the means and medians. However, the difference between the means and the medians is projected to decline steadily from 1970 to 1975, indicating that users who are off to a later and slower start than others will experience the largest percentage gains in the size of their collections. The current monthly growth rates of the thirty-three users are shown in Table 3. Ten indicated that they expect their growth rates to increase, nineteen indicated that they expect their growth rates to remain about the same, and four indicated that they expect their growth rates to decrease. Only a few users indicated that they expect to set a ceiling on the size of their collections--a ceiling maintained through periodic weeding of the collection.

4.0 DESCRIPTION OF USERS AND THEIR MICROFICHE SYSTEM REQUIREMENTS

4.1 CATEGORIZATION OF USERS

Because of the wise variances in the size, activity, and status of the microfiche operations surveyed, there is little basis for formulating a common set of user requirements. Accordingly, users have been grouped into three categories for analysis:

A. Technical libraries and information centers.
B. Bench-level users.
C. Order desks.

YEAR	MIN-MAX RANGE	MEAN SIZE	MEDIAN SIZE	NUMBER USERS UNDER 5K	NUMBER USERS WITH 5 - 10K	NUMBER USERS WITH OVER 10K
1970	100-35,000	4000	600	28	0	5
1972	400-40,000	5500	1800	21	7	5
1975	600-70,000	8300	3500	21	7	5

Table 2. Microfiche Collection Profile for 33 Users*

NUMBER OF USERS	MONTHLY GROWTH RATE (1970)
13	10 - 25
7	26 - 50
4	51 - 75
5	76 - 100
1	101 - 200
2	201 - 400
0	401 - 1000
1	1000+

Table 3. Microfiche Collection Growth Rate of 33 Users*

*The 33 users who ordered between 200-1000 $\pm$ 50 microfiche from DDC during calendar year 1969 and maintain central collections.

The distribution in the sample of thirty-three users meeting the small-user criterion is twenty-two technical libraries and information centers and eleven bench-level users. (Table 1 identifies all fifty users surveyed as being in category A, B, or C.)

In establishing the above categories and assigning users to each category, some approximations were necessary. Not all users can be neatly pigeonholed into one category. Technical libraries, for example, generally subsume the activities of an order desk in serving bench-level users. But the categories quite accurately set apart the different users surveyed and are useful in assessing system requirements in each case.

The following paragraphs 4.2, 4.3, and 4.4 describe the users in each category and their system requirements.

4.2 TECHNICAL LIBRARIES AND INFORMATION CENTERS (CATEGORY A)

4.2.1 Description

Users in this category constitute the largest group (22). They are in the information dissemination business. They exist to serve bench-level users, who are mostly RDT&E personnel seeking information. This distinction, although obvious, is important because it leads to a different set of microfiche system requirements. Apart from the size of their total document-handling operations and the current status of their microfiche operations, users in this category perform essentially parallel operations--exceptions are noted in the discussion. The present (1970) and projected (1975) mean microfiche collection sizes of the twenty-two users in this category are approximately 5,000 and 13,000 respectively, with the median size being much smaller because of the skewing caused by the collection sizes of the five largest.

Because these users are in varying stages of conversion to microfiche operations, their stated requirements also vary widely. Those users who are just

beginning their microfiche operations, or who are now ordering microfiche against the day when they expect to begin microfiche operations, tended to be less definitive about their requirements. It is reasonable to assume that their requirements, over time, will more and more converge with those of the active, experienced users surveyed because of the similarity of their total document-handling operations.

The equipment owned or leased by users in this category points up the present differences in status. At one extreme are users who have no microfiche equipment whatsoever, even though they have microfiche. At the other extreme are users who have a full complement of equipment--readers, reader-printers, fiche-to-fiche duplicators, and cameras and film-processing equipment. In-between are users who have one or more readers and users who have one or more readers and/or reader-printers.

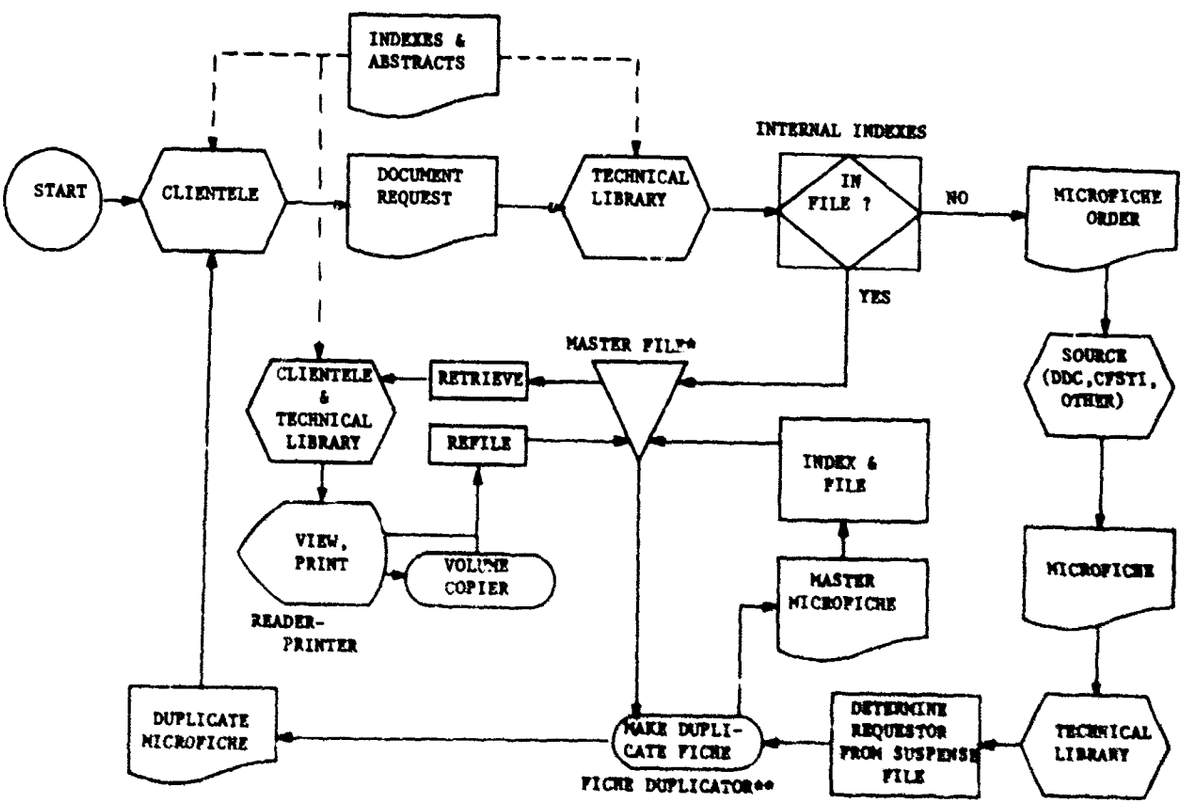
Significantly, the users who appear to be most experienced in using microfiche do not cite space or cost savings per se--important though they are--as the dominant reason for using microfiche. The dominant reason cited is their ability to provide better, more timely service to their clientele. Their overriding objective is to have technical reports on hand when they are needed. They seek to minimize, as much as possible, the need to order a document when it is requested; they want to have it already on hand when it is requested to avoid delays that may make the information "too late". A second key reason advanced for using microfiche is that the physical concentration of the collection makes access time and filing time shorter, thus reducing overall labor costs and even making possible economical self-service operations. The factors of acquisition cost savings, storage-space savings (both floor space and the costs of hard-copy file cabinets--especially expensive classified file cabinets), file concentration, and shorter cycle time in acquiring and disseminating microfiche all combine to make it possible to establish and maintain a more complete, more current technical-report collection in

microfiche form than in hard-copy form.

On the other hand, several of the technical libraries who are just starting their microfiche collections appear to be mainly preoccupied with cost and document storage--space problems, and the deficiencies of the medium and associated equipment. They are reluctant or resigned converts who are ordering microfiche because they are running out of space, can't affort the cost of hard copy, or both. They have not advanced to the stage of concentrating on the possibilities for improved overall service through the acquisition and dissemination of microfiche. As time passes, it is probable that most, if not all, of them will advance to that stage. The transition is not easy, is not accomplished "overnight", and certainly the deficiencies of microfiche technology are real.

As previously indicated, virtually all users in this category perform parallel operations. They acquire, index (with or without a thesaurus), store, search, and retrieve from a central technical-report collection. They order technical reports for their clientele and perform searches for their clientele. They prepare and distribute current announcement lists, and they maintain standard reference works and periodicals. Typically, they are directly or indirectly responsible for surveying and meeting the needs of their clientele for microfiche equipment (e.g., readers). All of these functions are performed with varying degrees of sophistication and thoroughness, depending on the size of the operation, budget, and expertise available. A representative information-flow diagram of their microfiche operations is shown in Figure 1.

Two users constitute an exception to the pattern described above. They function as completely centralized information centers and their operations are considerably more restricted in scope. They maintain a central collection of their own technical reports, i.e., a master collection that is



* An optional practice is to maintain a complete working file separate from the master file for clientele searching of the collection.

** An optional practice is to order 2 microfiche--one for the requestor and one for the central master file.

Figure 1. Representative Flow Diagram for Active Technical Library

homogeneous in character. No loans are made from the collections; the clientele come to the collections. Ancillary functions such as ordering reports for clientele, maintaining periodicals and references, distributing current-awareness announcements, and printing reports for clientele are not performed. They acquire, index, store, search, and retrieve from the central collection, and provide their clientele with access to the collection. Unless their operations change, their overall microfiche system requirements will remain more modest than those of other users in this category and are so distinguished in paragraph 4.2.2. A representative information-flow diagram of their microfiche operations is shown in Figure 2.

All twenty-two users in this category presently have manual storage files for microfiche; card-file cabinets are the most common. One user is planning to purchase a power file; the rest have no firm plans for changing from manual files. They do not see modular expansion of their manual files to constitute a problem; nor do they see misfiling to constitute more than a minor problem.

The indexing practices among these users range from complete reliance on externally furnished indexes, such as TABS, to sophisticated computer-based systems. In between are cross-referenced card-catalog files, manual notebook index, Termatrex indexing and search systems, and machine-generated indexes in book form. Some users employ combinations of those techniques.

Despite the heterogeneity of these indexing practices--especially the depth of indexing--there are commonalities that have significant implications in considering automated microfiche storage and retrieval devices: (1) technical reports are commonly indexed as whole documents, not page-by-page;* (2) the

*Only one user among those surveyed indexes on a page-by-page basis; his technical report collection is formatted to make this practical. Page-by-page indexing does appear practical for those users whose holdings are uniformly formatted with standard page layouts or groupings.

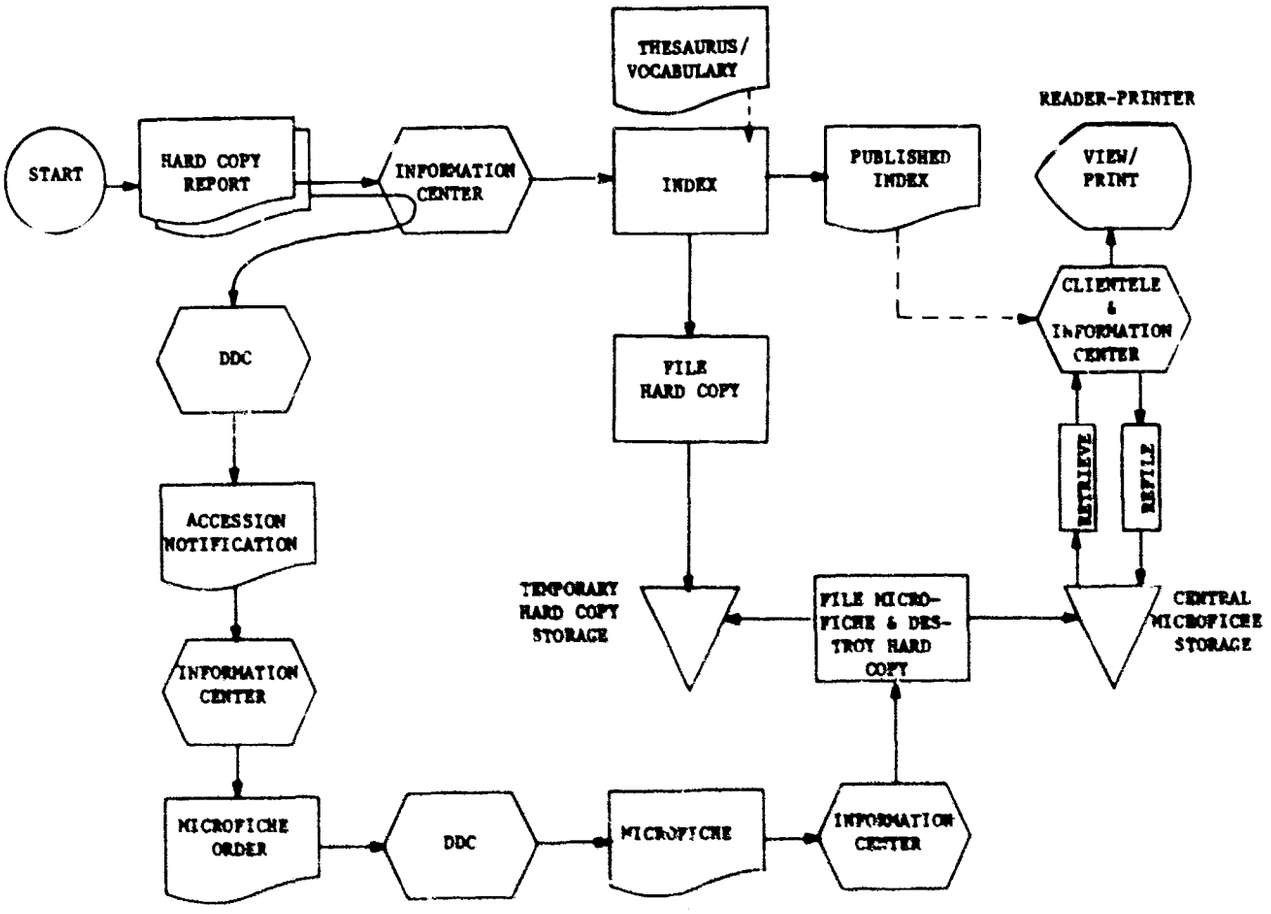


Figure 2. Representative Flow Diagram for Centralized Information Centers

indexing provides multiple access points to the collection (descriptors, titles, author names, contract numbers, etc.); and (3) the indexes are separate from, not an integral part of the manual storage device. That is, the indexes lead to an accession number and the reports are physically filed in ascending accession number order. Some users file by externally assigned accession numbers (e.g., AD, PB, or N number) and others assign internal accession numbers and cross-reference the externally assigned number.

4.2.2 Overall Microfiche System Requirements

The foremost need of this user group is an adequate set of external and search tools; this requirement receives the most attention and is the greatest cause for concern. A number of users in this category believe that their indexing is inadequate; the reason given is that they do not have the manpower to do a thorough job.

Secondly, these users have a requirement to make the accessioning time cycle as short as possible. One vehicle for meeting this requirement is automatic distribution, provided profiles can be formulated with sufficient specificity and accuracy to hold the volume of unwanted reports to an acceptable level. If the profiles are too gross, the processing workload becomes excessive.

Third, these users need an adequate supply of readers and reader-printers co-located with the central microfiche collection, and an adequate supply of dispersed readers to encourage the use of microfiche by their clientele. Typically, one centrally located reader must be reserved for use by the indexers. No shortage of centrally located readers and reader-printers was reported; conversely, there were several reports of a scarcity of dispersed readers, which is inhibiting acceptance of the medium by the users' clientele. Centrally located reader-printers are needed for direct use by the libraries' clientele and the libraries themselves. The number of dispersed readers needed is a function of the number of clientele being served and the scattering of the clientele--if the clientele are all in the same building as the library,

the requirements are less than if they are scattered among several buildings. Desirable ratios expressed are one reader for every three bench-level users to one for every five served by the libraries.

Fourth, based on the operations and plans of the more advanced and experienced users, there is a growing requirement for a faster, higher-quality, cheaper, dry-process, multi-hard-copy print capability from microfiche. The users forsee a continuing legitimate demand for hard copy from microfiche. It is quite common for these users to make a "master" copy from a reader-printer and then make copies in quantity from office copiers and conventional printing equipment.

Fifth, and again based on the operations and plans of the more advanced and experienced users, there is a growing requirement for a low-volume fiche-to-fiche duplicating capability. Only a few users now have this capability, but SDC believes this requirement will spread. Like DDC, these users are perceptive to the fact that they can more economically meet multi-user demands for the same technical report by making and distributing duplicate microfiche, often on a give-away basis, which reduces record keeping labor costs. This applies to both internal and external technical report requests. This capability also enables the libraries to assist their clientele in building up specialized satellite collections. Further, it enables them to keep intact a master microfiche file. (One user in this category maintains two files--a master file and a working file; the working file is made directly available to clientele on a self-service basis and losses from that file through misfiling or other cause are easily replaced by duplicating fiche from the master file.)

Sixth, there is a growing requirement for access to, not ownership of, a microfiche filming and processing capability. A few users have their own equipment but, by and large, most users cannot justify the cost of such

equipment because their volume is too low. But, in making the transition to microfiche, a number of users have a one-shot requirement to convert as much of their hard-copy collection as possible to microfiche (above and beyond documents entered into the DDC system).

Seventh, there is a requirement for gradual expansion and, in some cases, upgrading of manual storage files. The beginning users will move from "shoe-box" files to card-file cabinets or equivalent storage. The overwhelming majority of the users foresee no need to change their operation from manual to mechanized files. A few consider automation of their files as potentially desirable, but not necessary, in view of the low retrieval rates associated with technical reports (a mean of about 3 retrievals per day at present). Present-day automated microfiche storage and retrieval devices are aimed at unit-record information applications (personnel records, customer accounts, product specifications, etc.) where an essentially on-line query and response capability is needed because of the volume of transactions--a situation that does not apply to technical reports. The appeals of an automated storage and retrieval device are threefold: maintenance of file integrity, no physical handling of the microfiche (automatic refiling), and--provided retrieval rates become high enough--labor savings. An intangible fourth factor is the psychological value of having convenient "pushbutton" access to a microfiche collection--some users believe this could promote clientele acceptance of microfiche.

In summary, the microfiche system requirements of technical libraries are, on a smaller scale, converging with those of DDC. In performing "mini-DDC" operations, the libraries must index their collections; distribute microfiche from their collections while maintaining a master file; conduct periodic searches as a service to their clientele; furnish hard copies from microfiche; and furnish duplicate microfiche to their clientele. Also, they must provide

their clientele with access to the collection and the equipment for viewing and printing from it. These are the services that the more advanced and experienced users are providing, and are the services that the late starters will begin to provide, in SDC's opinion, as time passes.

Two users were singled out as exceptions in describing users in the technical library/information center category. Their more restricted functions make for fewer microfiche system requirements. Essentially, what they need is one or more reader-printers (depending on the volume of transactions) co-located with their central collections. They may, in the future, have a requirement for a reader that they can loan to a customer on occasion. (Since they index only their own reports, which is done from hard copy, they do not need a reader for indexing purposes.)

4.2.3 Storage and Retrieval System Requirements

As indicated in the foregoing discussion, the users surveyed do not now view automated storage and retrieval devices as requirements, but as potentially desirable devices. Their immediate concerns center on reader viewing quality and versatility; good indexing tools; and higher-quality, cheaper, and faster hard-copy printout from reader-printers. As of now, and for the near future, retrieval from a manual file through the use of good index and search tools is considered an adequate solution. This is so because retrieval rates for technical reports are characteristically low in relationship to the size of the collections (this is a characteristic that applies equally well to hard-copy collections); the time differential between retrieving and refiling from a manual file and an automated file is not significant where retrieval rates are low. Also, the misfiling as with manual files does not constitute a serious problem.

Another characteristic of technical reports is that they are typically read and studied at length. Thus, "instantaneous" lookup is not a requirement. This is a contrast with the applications for which present-day automated

microfiche storage and retrieval systems were designed. They are used for rapid page lookup to find a specific item of information or to retrieve single-page records uniformly formatted into well defined, easily remembered fields of information (for example, retrieval of all employee records whose age is over thirty-five--age being a field of information). Typically these systems are geared to a high volume of daily transactions, often on a telephone query and answer basis which usally requires assignment of a specific individual to perform the function. The systems also lend themselves to rapid lookup of records such as land grants, product specifications, and the like. They are not designed for low-volume retrieval of technical reports which are comprised of multi-page narrative information and are indexed as whole documents, not page-by-page; and they are not designed to handle the number of microfiche, on-line, that will exist in most user collections over the next five years. Further, the indexing normally used for technical reports greatly exceeds the indexing capability of those systems. Typically, those systems rely on numeric and alphanumeric codes that are severely limited in scope; the natural-language requirements of technical-report indexing (authors, descriptors, titles, etc.) cannot be met by any but the most costly experimental film-storage devices. For all practical purposes, present and projected low-cost systems (under $10,000) are limited to coding essentially the accession number or equivalent of technical reports. Such systems could be used, for example, to access technical reports by contract number--but that is only one attribute of many by which technical reports must be retrieved.

The foregoing remarks are negative in character. Nevertheless, several users expressed interest in some form of mechanization of their microfiche files for the future--interest ranging from hand-cranked rotary files and powered rotary files, to high-cost computer-controlled-access storage and retrieval devices having remote display terminals. The latter devices are clearly out of the question for practically all of the users surveyed; the costs are simply too high. But automated features such as pop-up capability,

pushbutton access, random filing, and automatic refiling, user convenience, and potential overall labor savings overshadow retrieval rates as factors in considering the design of an automated storage and retrieval system that will prove cost-effective to these users. Another important consideration is that microfiche collections are much more susceptible to a self-service mode of operation than are hard-copy collections. Automation of the collection, with assured file integrity, would possibly overcome objections, by library personnel, to that mode of operation. (A possible useful adjunct to such a system would be a built-in capability to produce duplicate microfiche, on demand, from the master file.)

4.3 BENCH-LEVEL USERS (CATEGORY B)

4.3.1 Description

The eleven users in this category are RDT&E individuals or close-knit working groups who order microfiche for their personal collections. They are distinguished from technical libraries and information centers in that they are primarily seekers of information, not disseminators of information (although, in the end, what they produce is disseminated). They order microfiche directly from DDC, CFSTI, and other sources, or through an order desk, or both. These users may have access to a larger central collection elsewhere in their facility (e.g., a technical library), but they want their personal collections at their fingertips. Typically, the present size of their collections is under 1,000; the largest projected size of any collection in this user category is 5,000 microfiche by 1975. (It is worth noting, that, although collections of this size may be regarded as relatively small, the average bench-level user could not possibly maintain an equivalent collection in hard-copy form.)

The type of microfiche operations engaged in by these users is best described as being informal and self-service. That is, they order, store, retrieve,

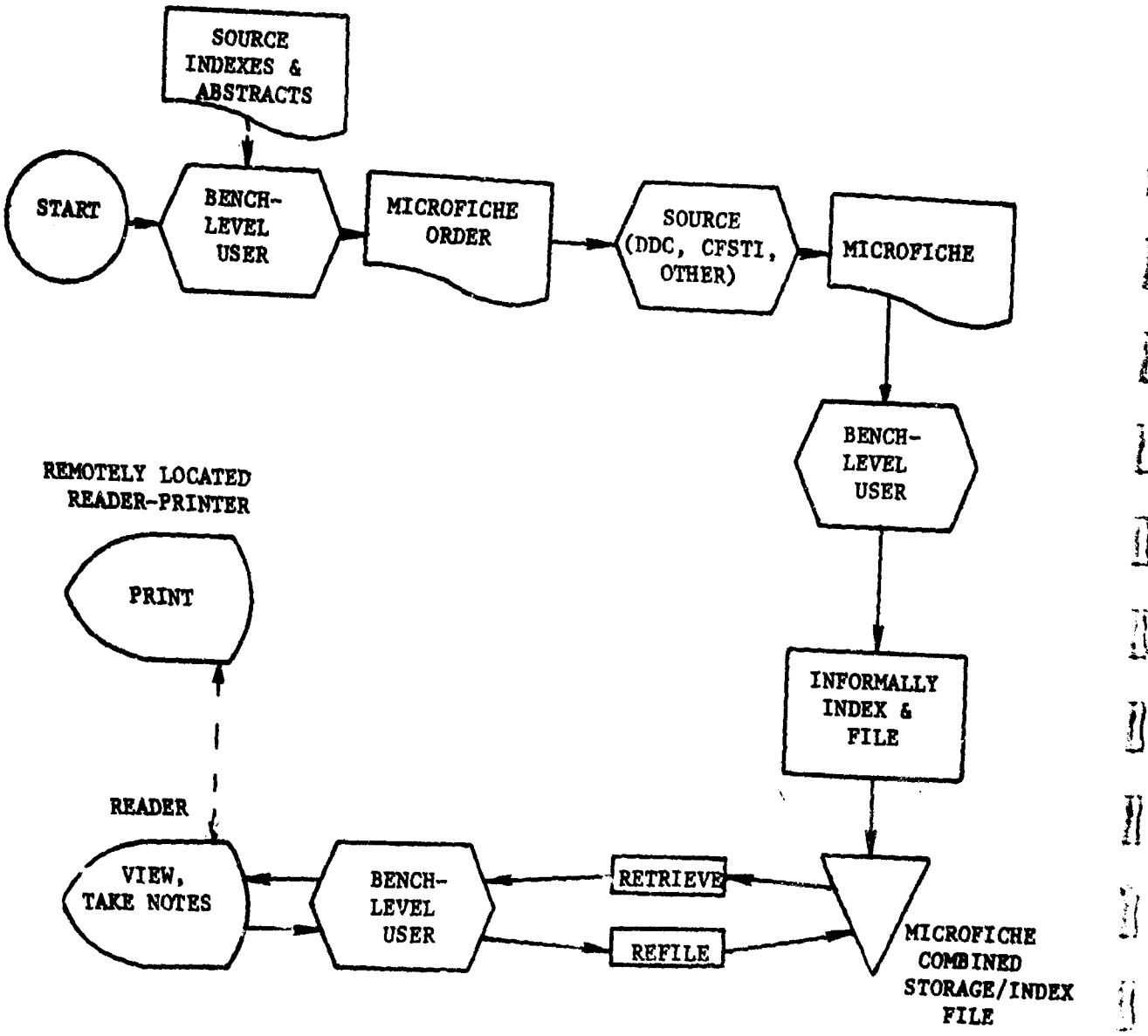


Figure 3. Representative Flow Diagram for Bench-Level Users

and view personal collections on their own, without the assistance of professional librarians and information specialists. In a sizable group, a secretary or clerk may be called upon to maintain microfiche logs and files. An individual may share his personal collection with his colleagues; conversely, a group may share a common collection. A representative information-flow diagram of their microfiche operations is shown in Figure 3.

Indexing may be non-existent, consist of self-generated subject headings, and (in rare instances) even include the utilization of data-processing services to generate and update a book-form index. The most common form of indexing is self-generated subject headings on cards, which are used as separators in filing the microfiche.

All users in this category presently have manual storage files. These include envelopes, desk drawers, desk-top card files, card-file cabinets, and hard-copy file cabinets (particularly for classified microfiche). Their equipment is typically limited to readers, with the individual or group having access to a reader-printer. The readers are normally shared, although occasionally an individual may have his own reader.

Users in this category access their collections sporadically. They may go days or weeks without accessing the collections and then spend significant parts of several days in a row viewing microfiche. Overall, their mean daily retrieval rate is about two microfiche. They tend to order microfiche in the same way--it is usually done in "bunches" on an as-time-permits basis or when the latest index and abstract bulletins arrive.

4.3.2 Overall Microfiche System Requirements

These users want technical reports on hand when they need them. The time requirements cannot be quantified--depending on the project at hand, a report may be needed in minutes, days, or weeks. The only possible way to state this requirement is that documents should be on hand, when needed, insofar

as possible; the time cycle for ordering and receiving microfiche not on hand should be as short as possible.

These users need a set of TABS, USGRDR, and similar indexes to find technical reports of interest. At their option, these indexes should be provided in either hard copy or microfiche form. In most cases, their requirement for subject indexing is presently being satisfactorily met by self-generated descriptions; cross-reference to authors, originating agencies, and the like; and individualized colored tab coding schemes. Their indexes are tailored to their own specialized needs--a general-purpose thesaurus is not adequate for their purposes. As their collections grow, SDC believes these users will require assistance in indexing, such as data-processing techniques that will enable these users to maintain a more formally organized but personalized index with a minimum of effort; one user, in fact, considers indexing assistance to be his most pressing requirement.

Sufficient readers must be available to minimize queuing problems. And the readers must be located in the users' offices--convenient access is highly prized

Although these users have an occasional need for making hard copy from microfiche, they lean toward note taking. Collectively, they require access to a reader-printer; they cannot justify the cost of having their own reader-printer and do not usually have the staff to perform the servicing required. (One user group in this category does have a reader-printer; it has been covered for months because the servicing required was not commensurate with the use it received.)

4.3.3 Storage and Retrieval System Requirements

Through the 1975 time period, SDC believes storage and retrieval requirements for the majority of bench-level users can be technically and economically

satisfied by retrieval from manual storage files with the aid of external indexes. However, a few bench-level users can be expected to develop, because of exceptional growth or special needs for urgency or file integrity, a requirement to mechanize the storage and retrieval process. A modularly expendable system of modest cost, with a capacity of up to 10,000 microfiche, should adequately meet the requirements of this type of user.

4.4 ORDER-DESK USERS (CATEGORY C)

4.4.1 Description

Users in this category function solely as ordering and dissemination points for microfiche. They are middlemen and do not, themselves, maintain microfiche collections and equipment. They order microfiche for bench-level users and disseminate it upon receipt. Except for maintaining of current and completed orders, they do not normally account for the microfiche that pass through their hands. An exception is classified microfiche; some order desks perform the security control function. They charge out the fiche when it is no longer needed. They may maintain a set of TABS, USGRDR, and other external indexes to assist their clientele in searching for documents of interest. A representative information-flow diagram of their microfiche operations is shown in Figure 4.

4.4.2 Storage and Retrieval System Requirements

Within the scope of this study, these users have no microfiche storage and retrieval system requirements. The bench-level users they serve, as previously described, do have requirements.

4.5 RECAPITULATION OF USER MICROFICHE SYSTEM REQUIREMENTS

A condensed summary of the typical major microfiche system requirements of users at various levels is given in Figure 5. DDC, which has the most extensive requirements, is used as a "yardstick" against which to measure

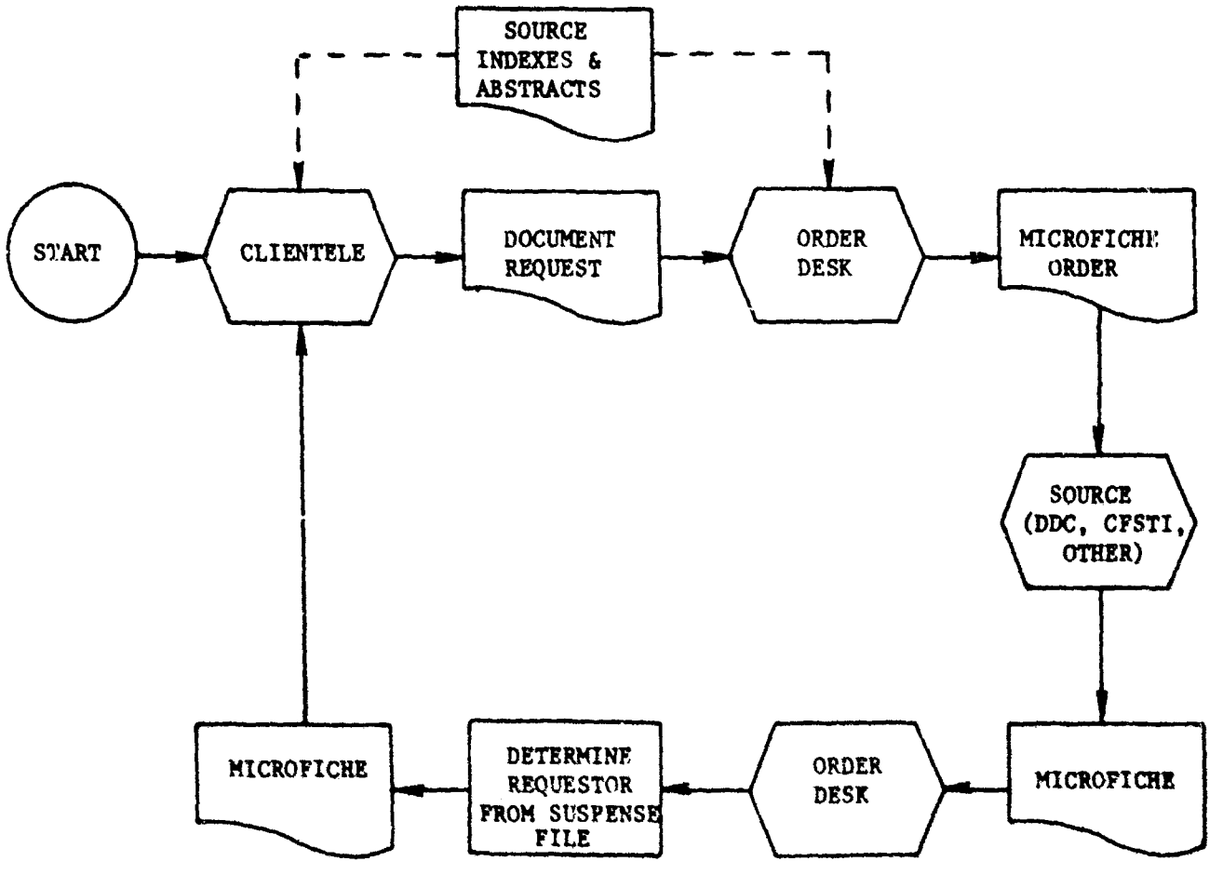
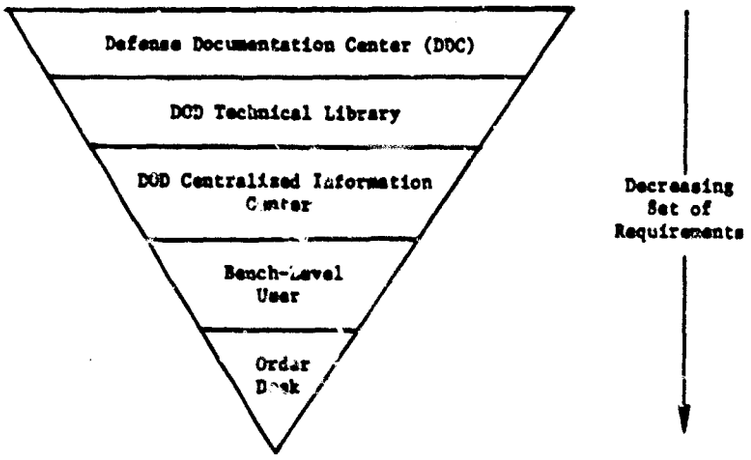


Figure 4. Representative Flow Diagram for Order Desk



DDC

1. High-volume camera and film-processing capability.
2. High-volume hard-copy print capability from microfiche.
3. High-capacity powered master and duplicate microfiche files.
4. Sophisticated indexing and search capability.
5. Short acquisition and dissemination time cycle.
6. Automatic selective distribution capability.

Technical Library

1. Low-to-medium-volume hard-copy print capability.
2. Low-volume fiche-to-fiche duplicating capability.
3. Occasional access to camera and film-processing service.
4. Adequate supply of central and dispersed readers and reader-printers.
5. Moderate-capacity central manual storage file.
6. Sophisticated indexing and search capability.
7. Short acquisition and dissemination time cycle.

Centralized Information Center

1. Centrally located reader-printer.
2. Moderate-capacity manual storage file.
3. Sophisticated indexing and search capability.
4. Short acquisition time cycle.

Bench-Level User

1. Adequate supply of readers in office.
2. Occasional access to reader-printer.
3. Occasional access to technical library central collection.
4. Low-capacity manual storage file.
5. Unsophisticated indexing and search capability.
6. Short acquisition time cycle.

Order Desk

1. Short acquisition and dissemination time cycle.

Figure 5. Comparison of Typical Microfiche Requirements at Different User Levels

users below them in the inverted pyramid. As indicated, the requirements are typical only; there are exceptions at every level below DDC. For example, not every library now has a sophisticated indexing and search capability or a fiche-to-fiche duplicating capability; SDC predicts that, in time, most of them will. An occasional large bench-level user group may be able to justify the cost of having its own reader-printer; SDC predicts that most of them will continue to share access to one maintained at a higher organizational level. Finally, SDC predicts that, by 1975, several of the larger libraries and a few of the larger bench level groups will find that an automated storage and retrieval capability will be a cost-effective alternative to their present manual storage files.

5.0 SUMMARY OF USER COMMENTS CONCERNING MICROFICHE

The coverage in this section is confined to simply listing specific comments made by the users in the survey sample. The comments are in the same vein as those extensively reported in previously published studies.

5.1 WHY USERS ORDER MICROFICHE

The following reasons were cited:

A. Institution of the $3.00 charge for hard copy by DDC/CFSTI.

B. Improved timeliness and availability of technical reports

C. Microfiche is an inexpensive screening device to determine whether or not it would be worthwhile ordering the hard copy.

D. Critical space problems--either actual or impending.

E. Microfiche is a fact of life--it is here to stay.

F. It has value for long-term or archival storage.

G. It is easier to print a page from microfiche than from a bound hard copy.

H. Microfiche can be economically duplicated to fill external requests and to establish satellite files.

I. A microfiche file can be more quickly accessed because it is more concentrated. Also, this concentration makes possible economical

self-service operations.

J. It is cheaper to order a short document on microfiche and print a hard copy of it than it is to pay for the hard copy from DDC.

K. Microfiche makes it possible to maintain larger document collections.

L. Classified microfiche are easier to control than classified hard copy.

5.2 WHAT USERS DON'T LIKE ABOUT MICROFICHE

The following reasons were cited:

A. Image quality is sometimes poor.

B. The medium requires the interposition of equipment between the reader and the written word.

C. Intensive study of a document is much more time-consuming. Flipping pages back and forth, particularly to find references, is not possible. This problem is particularly annoying when trailer fiche are involved.

D. Protracted use is fatiguing.

E. It's not possible to write on microfiche. It is difficult to write on glossy-finish blowbacks.

F. Classified microfiche are harder to control than classified hard copy (as indicated in paragraph 5.1, some users disagree).

G. It is easy to remove a sensitive page from a hard-copy document. It is impossible from a microfiche. Removal of the sensitive page lifts the distribution restrictions on the document. Thus, microfiche inhibits distribution.

H. Negative photographs and other illustrations are difficult to interpret.

5.3 WHAT USERS WANT IN MICROFICHE READERS

Better readers at a lower cost are wanted, although many users are reasonably satisfied with the ones they have (budget limitations obviously preclude

replacement of readers everytime an improved model comes on the market). All of the often-cited technical improvements are wanted:

A. Image-rotation capability.

B. Greater portability so users can take readers home or on trips.

C. Less light intensity and screen glare to reduce eye fatigue.

D. A viewing angle which reduces neck fatigue.

E. Variable-magnification capability to compensate for the various reductions and type sizes of documents put on microfiche.

F. Even, sharp focus over the entire screen.

G. Mechanical features to speed up page advance and to facilitate back-and-forth browsing and referencing.

H. A polarity-reversing capability built into the readers or positive images of fiche for photographs and other illustrations.

I. Fiche holders positioned to minimize arm fatigue (should not be at the top of the reader).

An increasing number of readers are now on the market and are reaching the market which meet many of the foregoing demands--the foregoing comments apply to the equipment the users have on hand. Ideally, what is wanted is a reader that will enable users to handle microfiche as conveniently as they can hard copy, which is a formidable and probably insoluble task.

3.4 WHAT USERS WANT IN READER-PRINTERS

The users want increased print speed, dry-process copies, more durable copies (no curling or fading), and a capability to "dial" the number of copies to be printed and the pages to be printed. A minority of the users have sufficient volume requirements to warrant purchase of an enlarger-printer now; over time, SDC sees this as a growing requirement.

6.0 EXPLORATION OF ADDITIONAL OR REVISED DDC SERVICES

DDC's services are highly regarded by, and are invaluable to, the users surveyed. The forthcoming implementation of both a positive and negative microfiche service, the microfiching of DDC's older collection, and improved hard-copy reproduction from microfiche will further add to the value of the services.

Some users are faced with manpower and budgetary problems that inhibit their ability to do as thorough a job as they would like. In particular, any DDC service that would reduce the labor involved at these user agencies would improve their ability to provide better overall service. Based on user comments and its own observations, SDC recommends that the feasibility of providing the following services be explored, if they have not been or are not now being explored:

A. Automatic microfiche distribution to the originating agency of its own technical reports. In making the transition from hard-copy collections to microfiche, a number of users are going through old TABS and USGRDR indexes with the objective of gradually ordering all of their own previously published reports on microfiche. They are also ordering microfiche of their new reports when notified, by DDC, that the reports have been accessioned. (One user, in fact, enters his agency's reports into the DDC system for the express purpose of ordering microfiche once it has been accessioned by DDC.) The announced intention of DDC to microfiche its older collection (upon demand) will undoubtedly trigger another round of this look-up and ordering activity so that the users can convert as much of their own hard-copy reports to microfiche as possible. Automatic distribution of a user's own reports would: (1) eliminate the labor involved in looking up reports in the indexes and processing the orders; and (2) speed up the delivery time.

B. Print and distribute separate cumulated TABS and USGRDR indexes for

each COSATI subject field/group. The present TABS format is well suited for current-awareness use. The suggested format would provide a useful retrospective search tool in the users' respective fields of interests. As presently formatted, retrospective searching of the indexes is so laborious and time-consuming that using the indexes for that purpose is not very practical.

C. Provide, as an optional service and as a by-product of DDC data-processing operations, a set of index or catalog cards with each microfiche. This is suggested as an optional service because many users who have highly specialized indexing requirements, and the capability to meet them, would not want the service. But a considerable segment of the user population finds it impossible or difficult to do even a minimum amount of indexing. A set of index cards that would enable these users to establish card files by accession number, report number, author name, title, and contract number would materially assist them.

D. Provide, as an optional service, low-cost microfiche filming and processing of users' older hard-copy collections to encourage conversion of files to microfiche. Alternatively, DDC could serve as a focal point in directing users to government agencies who have an under-used capacity for making microfiche.

E. Provide consulting services in the design of improved indexing tools. For example, there appears to be a trend toward furnishing computer-generated and updated book-form indexes to library customers because they are considered to be more convenient to use than card-catalog files.

F. Promulgate, through the DDC Digest, case studies of successful microfiche operations to acquaint beginning users with what has been and is being done in the field. For example, some technical libraries have found it practical to make their microfiche collections available on a self-service basis, thereby significantly reducing library manpower requirements.

PART III

MARKET SURVEY

1.0 INTRODUCTION AND SUMMARY

1.1 PURPOSE AND METHODOLOGY

This section of the final report documents the market survey of the small user activities visited by the SDC study team. The purpose of the market survey is to measure the potential demand by small users in the military community for storage and retrieval systems and related reader-printer equipment in the next two to five years.

Data was collected from industry representatives, other professionals, a review of current literature, examination of specific equipment specifications, and interviews of a sample of small DDC/DoD microfiche users. Data collected was organized and examined to identify market trends, future equipment requirements, relevant user plans, user attitudes, and other significant factors which might limit or enhance the size of the market for microfiche storage and retrieval systems through 1975.

The product of the above data analysis is a set of logical conclusions, supported by facts and rational assumptions, which represent the best thinking of the study team. Conclusions were developed through comprehensive examination of findings and careful consideration of alternative interpretations of the data available. It is the opinion of SDC that the conclusions presented in this report are valid for the DDC/DoD user group represented by the sample surveyed.

1.2 SUMMARY OF CONCLUSIONS

a. Today, the market for automated storage and retrieval systems in the DDC/DoD small user population is very small,

perhaps non-existent. Chief factors relate to low activity levels and negative user attitudes.

b. Between now and 1975, the market can be expected to grow. If all variables are positive, the demand for storage and retrieval systems could approach 300 units in the DDC/DoD small user population alone. Variables include the influx of more readers, improvement of microfiche and equipment quality, increase of user awareness, improvement of microfiche image, and stability of microfiche/hardcopy price relationship.

2.0 ANALYSIS AND CONCLUSIONS

The discussion which follows is based on information derived from user interviews, contacts with industrial representatives and other professionals, examination of equipment specifications and review of current literature relevant to the survey. A description is provided of the present market environment including consideration of the level of microfiche activity and the general attitudes which exists in the small user population. Factors contributing to the nature of the future market are examined. These factors include collection growth rates, special user needs and other considerations which may limit or enhance the size of the 1975 market.

All estimates are based on the sample of small DDC/DoD users which were visited during the course of this study. Of the fifty (50) facilities visited, thirty-three were both small (based on annual microfiche orders) and maintained central microfiche files (making them candidates for storage and retrieval equipment users). The performance and characteristics of these thirty-three users provide the basis for numerical projections made in the course of the data analysis.

2.1 MARKET SURVEY FINDINGS

2.1.1 Present Market Environment

At the present time, all facilities surveyed (including the larger users contained in the visit schedule) are storing and retrieving microfiche using manual devices and techniques. Microfiche collections housed in central files range in size from 100 to 35,000 in the small user category. Over 85% of these collections are under 2,400. The median collection size is 600.

	Central File Sizes
Range	100 - 35,000
Range, excluding largest five users	100 - 2,400
Mean size	4,000
Mean size, exluding largest five users	785
Median size	600

The level of activity of each of these files can be best measured by the rate or frequency at which they are entered and microfiche removed for use. Retrieval rate, computed on a daily basis, range from 0 to 30 microfiche for all small users. 80% of the sample reported 3 per day or less. The average daily rate is 3.6 microfiche. Daily median is 2.

	DAILY MICROFICHE RETRIEVAL RATE
RANGE	0-30
Mean Rate	3.6
Median Rate	2

At this time, users sampled generally feel that their needs are being adequately met by the storage and retrieval systems currently in use. Few can envision a requirement for automating the retrieval process and those who can, do not see it as a requirement which will develop in the next five years, at least not on the basis of retrieval rate alone.

It cannot be assumed, however, that there is not a market for an automated storage and retrieval device at users whose activity levels are higher than that of the small users surveyed. Nor can we immediately rule out that some of the small users have special needs which could be solved by automating the storage and retrieval process.

Similarly, one may not assume that the current market description will necessarily apply in the near future. Most small users are growing steadily and, in some facilities, the growth is rapid. Requirements for microfiche systems are increasing and attitudes regarding microform technology can be expected to become more positive.

These and other factors which can be expected to affect the future microfiche storage systems market are detailed in the discussion which follows.

2.1.2 Future Market

During the next five years, the demand for an efficient, low-cost microfiche storage and retrieval system can be expected to grow. The microfiche file of certain fast-growing, small users will become larger and file activity levels should increase, thus creating a need for storage and retrieval devices. In addition, special user problems can be expected for which automated equipment can provide solutions.

Growth. Small DDC-DoD users will probably grow at an average rate of 550 microfiche per year during this period. Users' own estimates of the size

of 1975 collections range from a low of 600 to a high near 8,000. Based on these estimates, average collection size in 1975 will probably be near 3,500 microfiche. This estimate excludes considerations of the five largest "small" users, whose present collections already exceed the 8,000 figure and who cannot be considered typical of the small user group.

	GROWTH
1975 SIZE RANGE	600 - 8,000
MEAN 1975 SIZE	3,562

It is not expected that users growing within the bounds suggested above will necessarily develop a requirement for automating the storage and retrieval process. However, historical data indicates that some percentage of users grossly underestimate their future growth because of unexpected changes in organizational mission or operating policies. An example of this phenomenon, are the five users whose FY 1969 microfiche orders totaled less than 1,000, but whose CY 1969 orders increased significantly above 1,000 with order rates as high as fifteen times the previous rate. To the extent that this continues to happen, the ranks of the larger users will increase as will the resultant demand for storage and retrieval devices.

Special Needs. Some users can be expected to develop special needs which will add to the demand for automated storage and retrieval equipment. (To a certain extent, these needs already exist at some small user locations, though generally the users at these locations are yet to recognize the applicability of automated storage and retrieval technology to the satisfactions of those special needs.)

For example, file integrity is an advantage often associated with automated storage and retrieval systems. At facilities where file integrity (or perhaps

even file security) is of primary importance in the management of the microfiche collection, one might logically anticipate an equipment demand based on this single characteristic.

Also, a demand for equipment which can speed the retrieval of microfiche (even though retrieval may be infrequent) can be anticipated at those facilities where the time of the individual researcher is valued highly. The argument might be made that even though the central document file is entered relatively infrequently, it must be capable of near instantaneous response on those occasions when it is. When this argument is valid, a demand for equipment with retrieval-by-subject and random (batch) refiling, both time-saving characteristics, can be expected.

Funds. The survey revealed that funds for justifiable systems will probably be available in the future. Funds, at present, are severely limited and, in the immediate future, will probably continue to be limited. However, an eventual upswing can be expected and those users with justifiable requirements for additional microfiche related equipment can generally be expected to obtain the equipment required. Most users surveyed indicated that budgets governing spending at the user level did not include funds for equipment, and that decisions to purchase new microfiche equipment is made at a higher level. Most users feel that the only identifiable limit to the funds available for future microfiche systems will be a function of the priorities of other requirements competing for the available funds.

2.1.3 Other Considerations

Several variables distinguish themselves as having a potential effect on the size of the future microfiche storage and retrieval system market. The extent of the effect of each depends upon specific conditions which now can only be imagined.

Growth of Reader Numbers. One of the most significant factors affecting market growth will be the influx of additional microfiche viewing equipment, which is expected to be significant in the next several years. Estimates regarding overall anticipated viewer-to-individual user ratios range as high as one-to-five. In some facilities, the ratio may be as high as one-to-one. As these estimates are approached, demands for other microfiche materials and services can be expected to increase proportionately. Central files will be very active and the demand for automation will be greater.

Microfiche Quality. Microfiche and microfiche viewer quality is expected to improve. As more and more hard copy publishers generate camera-ready materials and as the state-of-the-art moves ahead in both emulsion and viewer technology, user acceptance of microfiche as a reading material will improve significantly. As acceptance improves, so will the market for all microfiche related materials and equipment.

Microfiche Price. User estimates regarding future growth rates generally assumed a continuation of the current microfiche to hard copy price relationship. At most locations, the price difference has been the primary force behind collection growth thus far, and it can be expected to play an important role in all future document ordering policies, especially until other growth factors gain in relative significance. An increase in the price of microfiche is certain to affect the size of the storage and retrieval equipment market, perhaps more so than the price of the equipment itself.

Microfiche Image. The image of microfiche in the eyes of the potential buyer will certainly be a significant variable affecting the size of the market. The degree to which each user is aware of the potential of microform technology will determine in no small way the amount he is willing to invest. At present, many potential users lack complete information regarding the applicability of this technology to their specific needs. Altering this situation during the next several years is a challenge which must be met primarily by the microform

industry itself through advertising, public relations and customer service.

2.1.4 Conclusions

The following conclusions are based on the relevant facts and assumptions as described and discussed in the previous section. All statements pertain to the population of military facilities registered with DDC which meet the criteria of small user as defined elsewhere in this report. This population numbers approximately 200.

a. The present market for an automated microfiche storage and retrieval system in the DDC/DoD small user population is very small, perhaps non-existent. This conclusion is primarily based on current activity levels and existing user attitudes. Few of the users surveyed expressed a desire for this type of system. No evidence could be found by the study team which could support an immediate requirement for such a system at the majority of small users surveyed.

b. The future market for an automated microfiche storage and retrieval system in the DDC/DoD small user population will probably develop to a significant size. No trend data is available to support an exact numerical projection, however, certain variables are identifiable which will affect market size between two predictable extremes. At a maximum, the size of the market within this population could approximate 300 based on one system for every small user currently registered including the possibility of additional devices at registered small users who serve multiple files. At a minimum, the market may remain at a level not unlike its present level.

It is not anticipated that either of these extremes will be the case. Most of the variables identified will probably operate as positive factors and push the market's size to at least the mid-range between the extremes defined above.

c. It is important to note that the calculations above do not reflect the size of the total market for a given type of equipment, but represent only the military small-user population which was sampled. Although beyond the scope of this study, a strong argument can be made that this market survey is applicable in large part to <u>all</u> DDC users in this size category and larger. This would enlarge the applicable user population to well over 1,000. Furthermore, if all DDC users <u>regardless of size</u> can be considered (which is a distinct possibility as growth in the lower ranks begins to accelerate in the more microform-minded environment of the future), the overall DDC user population to which these estimates apply may well exceed 5,000.

PART IV

STATE-OF-THE-ART SURVEY

1. INTRODUCTION AND SUMMARY

In this section, we will examine only presently available microfiche retrieval equipment and systems, and will discuss their characteristics, functions, capabilities, and weaknesses. Emphasis will be on the functional performance of the equipment/system.

A typical information storage and retrieval system, using microfiche as the storage medium, may be considered to have the following elements:

a. Announcement Function. Potential users of the information are informed of the availability of the information.

b. Search Function. Users of the system are able to search through the collection of information either directly or indirectly to determine which items they wish to examine. The search may be through catalogs, abstracts, indexes, or organized files of the fiche.

c. Locate Function. The identified fiche are located within the storage unit.

d. Transfer Function. The located fiche are transferred directly from the files to the requestor. Or, the fiche is transferred through an intermediate device, such as film duplicator, optical or electronic display or by creation of paper copies. The transferred material may be controlled, as a circulation copy, or disseminated without control.

e. Storage Function. New or returned items are entered into the storage unit. Necessary information is gathered and processed so as to permit the search and locating functions to work. Protective security procedures are introduced so as to prevent loss of the material, or disclosure of the information to unauthorized users.

This section will emphasize the locate, transfer, and store functions, and will not consider the announcement and search functions, except as they impinge on the other aspects of the system.

We will consider the following categories of equipment and systems:

a. Manual storage and manual display. Filing is serial, with manual storage and retrieval. Display is in a separate unit.

b. Random-access storage, manual display. Filing is random, with retrieval by keyboard action. Extraction is manual and display is in a separate unit.

c. Automated storage and retrieval. Filing and retrieval is automated, and may be either random or fixed location, depending on the system. Extraction of the fiche is automated; viewing may be manual or automated, depending on the system.

Our examination of these systems will show that current manual microfiche information retrieval systems provide many of the characteristics and satisfy many of the requirements for effective microfiche systems.

More automated systems are limited either in cost, or in capabilities, particularly capacity, but indicate the potential value of semi-automated or fully-automated systems.

2. MANUAL RETRIEVAL SYSTEMS

Manual microfiche retrieval systems usually consist of a storage unit, with the microfiche filed sequentially by accession number within the unit. Retrieval is accomplished by locating the fiche to be retrieved by manual search, extracting the fiche from the file, and manual processing subsequent to the retrieval.

Typically, the storage unit is a box of appropriate size, with dividers to provide visual reference to groups within a segment of the accession number series. Retrieval times from a single file, assuming that the accession number is known, has been estimated at 6-10 seconds, on the average.

Several different approaches have been developed to improve the handling of microfiche within a manual system. These approaches are summarized in tabular form in Table 1.

The approaches may also be categorized as follows:

1. Portable, Box. Small cardboard and metal file containers can be easily picked up and moved about. The boxes contain from 500 to 1,000 microfiche.

2. Fixed, File. Rows and tiers of metal file drawers each containing up to 2,000 fiche provide for serial searching of small to large collections. The containers may be stacked vertically as well as linearly.

3. Power Files. Vertical and horizontal power files may be adapted to use with microfiche. Each shelf in the file holds 6,000 or more microfiche. Access to a shelf is accomplished by button request. Search through the shelf is usually accomplished by only one person at a time.

4. Tub Files and Carrousels. For large collections, open files contained in stand-alone units, either linearly, as tub files, or in stacked, circular and movable bins, as in a carrousel. These approaches permit access to the files by more than one person at a time. The carrousel approach also permits locating work and viewing stations conveniently to the files.

5. Other Methods. Units have been developed to provide rack mountings of fiche. These are essentially plastic or paper pockets into which the fiche may be inserted. The pockets are sufficiently deep as to hold the fiche securely, while being sufficiently shallow to allow the title block of the fiche to show. The pockets may be housed in large

vertical racks, which can be pivoted open or closed. Or, the pockets may be housed in standard three-ring binders. The pocket approach permits limited browsing and identification of missing materials for control purposes.

Manufacturers of these storage units and devices include office equipment manufacturers, office furniture manufacturers, forms and paper manufacturers, and specialized office systems firms. Few of these companies market products exclusively to the microfilm users. A partial listing of manufacturers and suppliers is given in Table 2.

2.1 ADVANTAGES

1. Files can be closed for security or protection.
2. Storage techniques are similar to those for paper documents, and permit applications of developed coding techniques to be used with the microfiche.
3. The files are open-ended. Additional containers may be integrated into the system without difficulty.
4. Costs of the units are lower than more automated systems.
5. Retrieval times are 6-10 seconds from the time of entry with a known accession number to removal of the item from the file.
6. Mechanical aids to simplify search and selection procedures within the file have been developed.
7. New containers are being developed which permit filing on a non-serial basis, with browsing capabilities.
8. Capacity of manual systems is virtually unlimited.
9. File integrity can be assured with locking devices, binders, etc.

2.2 DISADVANTAGES

1. An external index is usually required.
2. Misfiling of one item within a large file may result in total loss of the information.
3. The microfiche must be removed entirely from the storage unit for viewing or for duplicating.
4. The filing and/or picking of fiche in quantity is fatiguing.

3. RANDOM-ACCESS RETRIEVAL SYSTEMS

Random-access retrieval systems usually consist of one or more trays of microfiche, connected by electric cabling to a keyboard. Each of the fiche stored within the tray has been modified by the addition of a metal clip, with unique coding entered into the clip. In some systems, the edge of the fiche itself contains the code (e.g., notches or pin-holes cut in film).

The usual coding method provides for alphanumeric characters to be entered in fields. Capacity may range from six characters to 12, 20 or more. Most serial requirements can be satisfied with a six-digit number (999,999).

The random-access approach does not customarily eject the selected fiche... rather, the selected fiche is positioned so as to show beyond the rest of the fiche. The selected fiche must be manually removed from the file. The selection may extend beyond that of a single fiche. Retrieval may be by any one, or combination of coding positions.

Retrieval times range from a claimed one second up to six seconds. Filing times are minimal, since it need be only to an open spot within a tray.

Power and other constraints usually limit the number of trays that can be simultaneously searched by single keyboard action to from 6-10 trays. Most of the systems do permit substitution of trays so as to permit active files to be immediately available, and less active files available by substitution.

The three most common methods of retrieval are:

1. Jogging. The fiche cards are jogged by the selector keys. The appropriate keys push upward against the coded strips. Travel for keys where the code appears is greater than for those fiche where the code does not appear. The selected fiche are pushed upward so as to extend above the pack.

2. Rejection. Through needles or magnets, selected fiche are held back while the unselected cards are rejected. The selected fiche are thus partially removed from the file.

3. Retention. Through p shrods, magnets, etc. unselected fiche are retained in a pack, while the selected fiche are partially removed from the pack.

3.1 ADVANTAGES

1. Each individual fiche is retrievable regardless of where it is filed.

2. No fiche can be lost within the file.

3. Retrieval times are minimal.

4. Groups of fiche can be retrieved at one time, where desired.

5. Limited logic sort and information retrieval can be obtained. Non-random systems provide only for item retrieval from a serial file.

6. Some statistical count of information groups can be obtained by retrieving the group.

7. Filing times and constraints are minimal.

8. The accuracy of the refile operation is noncritical.

3.2 DISADVANTAGES

1. Cost for hardware is relatively high, upward from $1,000 approximately for 1,000 fiche and about $600 up for each 1,000 additional to the maximum units.
2. Each fiche must be individually coded, adding to the cost and to the time.
3. Capacity of the system is limited.
4. The time of retrieval is only moderately supe ior to manual systems.
5. Operation of the equipment is somewhat noisy
6. The addition of coding strips to the fiche may ossibly reduce the quality of duplicated or viewed images.
7. Some equipment requires use of cards or jackets to provide stiffness required for retrieval.

Table 1 provides a brief summary of characteristics, and Table 2 a list of suppliers for random-access equipment.

4. AUTOMATED STORAGE AND RETRIEVAL SYSTEMS

Fully-automatic microfiche storage and retrieval systems provide for retrieval of designated fiche and display of individual frames of the fiche. Advance from image to image is automatic. Also included within this category are remote image systems in which retrieval of the fiche is accomplished by a clerk; subsequent processing is accomplished automatically.

These systems may be manually controlled through keyboard action, or may be controlled by computer intervention. In most applications in which computers are used, their use for control of the retrieval system is a part of a larger on-line information management system.

Each of the automated systems performs a unique application in which indexing within the fiche, and any external indexing are correlated to the use of the automated equipment. Typical applications include reservations information, telephone lookup, and on-line library catalog and book retrieval.

There are basically two types:

4.1 SELF-CONTAINED SYSTEMS

In these systems, all of the file information is contained within the microfiche reader. Capacity is limited to under 750 fiche. Coding strips must be used to mount the fiche within the units.

Access to the fiche is through designation of the accession number by keyboard intervention, access to an image may be through a single advance button, or through a designated row and column location. Under computer control, the fiche and image selection is made by the computer, either through program logic, or by light pen or button intervention. Retrieval times to the image are four to six seconds average.

4.1.1 Advantages

a. Access to specific images is very rapid, about four seconds, on the average.

b. The logical arrangement of the fiche, and of the information on the fiche can assist in simplifying the search, and reducing response time.

c. File integrity is assured, since fiche are not removed from the file.

d. The fiche are protected against dust and damage, since they are housed in a covered unit, and do not come in contact with other fiche.

4.1.2 Disadvantages

a. Equipment costs per file element are high, ranging from about $5.00 to $15.00 per fiche.

b. Capacity of the units are under 750 fiche, with no growth capability.

c. The accuracy requirements for automatic positioning of the fiche are high; higher than standard production techniques currently produce.

d. Duplicating the fiche is inconvenient and time consuming.

e. Preparing the fiche for use in the unit requires special equipment and high accuracy.

f. The units are complex; maintenance is significant, and downtime can be costly.

4.2 CENTRAL RETRIEVAL UNITS

In these units, retrieval is normally to the fiche, and not to the image. The user at a remote location enters appropriate selection information on a keyboard, or phones the request to the central location. Subsequent retrieval action may be manual, or may be automatic. The selected fiche is placed into position to be scanned by a television camera or videocon unit for transmission to the remote location. Retrieval times and quality are dependent on the transmission lines employed, and on the scanning device. High-resolution cameras have been used with wide-band transmission networks for rapid, quality display.

4.2.1 Advantages

a. Very large collections of fiche can be handled effectively.

b. Growth capabilities of the system are high. Additional modules for storage, or devices for processing of the fiche can be added easily.

c. Access to the central collection is available to many users from many different locations.

d. Satellite files are not required.

e. Response times of 4-6 seconds are common.

f. Secondary activities, such as hard copy or multiple copy printing and fiche duplication can be provided at the central location, or at remote locations, depending on the system requirements.

4.2.2 Disadvantages

a. Equipment costs are high, ranging upward from $50,000 for a bare-bones system to millions of dollars, depending on the system parameters.

b. Transmission networks and transfer problems add to the complexity of the system, and to the time response of the system.

c. The numbers of users on the system produce serious queuing problems, which often are solvable only through the addition of buffering and memory devices, which add to the cost and complexity of the system, and reduce the reliability of the system.

d. Communication or operating difficulties at the central file can effectively block the transfer of information completely.

e. High-resolution cameras are required to provide sufficient quality at remote locations.

f. Individual fiche can be lost through miscoding. The size of the file effectively prevents recovery of the missing fiche.

g. External indexing is required to permit most effective use of the system.

h. Maintenance and repair of the equipment becomes a significant requirement and constraint on the system.

i. In most cases, manual backup is not feasible, because of the mechanism used to pick a file from the file.

Table 1 provides characteristics of the automated retrieval systems. Table 2 provides a list of suppliers.

1. MANUAL, SERIAL FILE

KIND	CAPACITY	GROWTH POTENTIAL	CONVENIENCE & USABILITY	COST	PRIMARY ADVANTAGES	PRIMARY DISADVANTAGES
a. Cardboard Box	500-1,000	Limited, add-in additional boxes	Fair	Less than $100	Portable, low cost, simple filing, and good dust protection.	Low capacity, cover must be removed to use.
b. Metal Box	80-1,200	Limited, add-on additional boxes	Fair-good	Less than $200	Same as above, but cover hinged for convenience.	Low capacity, external index required.
c. Metal File Drawer Type	1,500-4,000	Add-on by stacking drawers	Good	Less than $500	Slide-out drawer.	External index required. Needs room to pull out drawer.
d. Metal File Slide Type	1,500-4,000	Add-on by linear placement of files	Good	Less than $500	Visible color coding feasible for quicker references. Access space less.	Requires dust covers when not in use. External index required.
e. Tub File	1,500-20,000	Add-on by linear placement of tubs	Very good	Less than $1,000	Simultaneous access to file by 2 or more users. Can be secured at night.	Large tubs not portable. External index required.
f. Rotary File	3,000-125,000	Good growth potential.	Very good	Basic-less than $1,000	High retrieval rates. Multi-users; can be powered.	Depends on well organized external index.
g. Power File (Vertical)	2,000-50,000	Excellent growth potential with add-on	Very good	Less than $2,000	Compact storage plus rapid access; file integrity high; can be used with automated viewing systems.	One person can access at a time.
h. Carrousel	6,000-millions	Excellent growth potential with add-on	Very good	Less than $2,000	Multiple access and work stations. Add-on uses little additional space. High volume use.	Depends on well organized external index.
i. Pockets	3-600	Add-on by linear addition of pages	Good	Less than $100	Visual check of missing fiche.	Low capacity. Inefficient as space-saver.

2. SEMI-AUTOMATIC, RANDOM

KIND	CAPACITY	GROWTH POTENTIAL	CONVENIENCE & USABILITY	COST	PRIMARY ADVANTAGES	PRIMARY DISADVANTAGES
a. Joggers	1,000-3,000 per tray (6 trays max.)	Fixed	Very good	$1,000-$10,000	Fast retrieval (1-6 seconds; minimal filing time.	Limited capacity. All fiche must be coded. May require mounting in jacket.
b. Rejection and Retention	2,000 per tray (10 trays max. plus change trays)	Fixed	Excellent	$5,000-25,000	(Same as above)	(Same as above plus higher cost)

3. AUTOMATIC, DEDICATED LOCATION

KIND	CAPACITY	GROWTH POTENTIAL	CONVENIENCE & USABILITY	COST	PRIMARY ADVANTAGES	PRIMARY DISADVANTAGES
a. Self-Contained	750	Fixed	Excellent	$4,000	Automatic operation plus fast image location (4 seconds). File integrity assured.	High cost per file element plus complex units in system; low capacity.
b. Remote (Control Retrieval Units)	To 2 million	Unlimited growth potential	Excellent	$100,000+	Rapid access to specific fiche (4-6 seconds, plus duplicating and hard copy printout. File integrity assured.	High costs, complex equipment, special queuing problems, plus special scanning equipment needed. Improper coding may result in loss of fiche.

Table 1. Basic Microfiche Retrieval Systems

	MANUAL						SEMI-AUTOMATIC	AUTOMATIC
	PORTABLE, DESK TOP	DRAWERS	TUBS	ROTARY & CARROUSEL	POWERED	POCKETS, ETC.		
Access Corporation 4632 Paddock Road Cincinnati, Ohio 45229							X	
Accurate Business Forms Co., Inc. 211 W. Kilbourn Ave. Milwaukee, Wis. 53203						X		
Acme Visible Records, Inc. 7412 W. Allview Dr. Crozet, Va. 22932	X	X	X	X	X	X	X	
Alpha-Vector 501 Fifth Ave. New York, New York 10017								X
Aigner J., Co. 426 S. Clinton St. Chicago, Ill. 60607						X		
Amberg File and Index Co. 1627 Duane Blvd. Kankakee, Ill. 60901						X		
Art Metal Jamestown, N.Y. 14701		X				X		
Art Steel Co., Inc. 170 W. 233rd St. Bronx, N.Y. 10463	X	X				X		
Atlantic Microfilm Corp. Micro-Folio Division 700 S. Main St. Spring Valley, N.Y. 10977		X						
Barkley Corp. 1220 W. Van Buren St. Chicago, Ill. 60607						X		
Beekley Corp. Data Systems Div. West Hartford, Conn. 06107						X		
Beemak Plastics 7424 Santa Monica Blvd. Los Angeles, Calif. 90046						X		
Bell & Howell Micro-Data Division 6800 McCormick Road Chicago, Ill. 60645						X		
Boorum & Pease Co. 84 Hudson Ave. Brooklyn, N.Y. 11201	X					X		
Borroughs Division Lear Siegler, Inc. 3002 N. Burdick St. Kalamazoo, Mich. 49003		X						
Browne-Morse Co. 110 E. Broadway Muskegon Heights, Mich. 49444		X						
Business Efficiency Aids, Inc. 8144 Lawndale Ave. Skokie, Ill. 60076	X	X	X			X		

Table 2. Microfiche Filing System Suppliers

	MANUAL						SEMI-AUTOMATIC	AUTOMATIC
	PORTABLE, DESK TOP	DRAWERS	TUBS	ROTARY & CARROUSEL	POWERED	POCKETS, ETC.		
Business Supplies Corp. of America 475 5th Ave. New York, N.Y. 10017		X						
Cal-U-Dex Inc. 23 MacArthur Ave. New Windsor, N.Y. 12550						X		
Cole Steel Equipment Co., Inc. Div. Litton Industries 415 Madison Ave. New York, N.Y. 10017		X				X		
Continental Dataforms & Supply Co. 3812 N. Kedzie Ave. Chicago, Ill. 60618	X	X	X			X		
Corry Jamestown Corp. E. Columbus Ave. Corry, Pa. 16407	X	X	X					
Cowan Plastic Products Corp. 50 Aleppo St. Providence, R.I. 02909						X		
Cytek Information Systems Corp. 366 Fifth Ave. New York, New York 10001								X
Data Products Co . 6219 de Soto Ave. Woodland Hills, Calif. 91364	X	X	X					
Data Sorter P.O. Box 268 New Cannan, Conn. 06840						X		
Demco, Inc. P.O. Box 268 St. Joseph, Mo. 64502		X			X			
Diebold, Inc. P.O. Box 231 Canton, Ohio 44702		X		X	X	X		
Dolin Metal Products, Inc. 315 Lexington Ave. Brooklyn, N.Y. 11216		X		X				
Dresser Products, Inc. P.O. Box 2035 Providence, R.I. 02905						X		
Eastman Kodak Co. 343 State St. Rochester, N.Y. 14650		X						
Elbe File & Binder Co., Inc. 649 Alden St. Fall River, Mass. 02722						X		
Elliot, B. K., Co. P.O. Box 3240 Pittsburg, Pa. 15230		X						
Execumatic Speedsystems 40 Collins Road Waban, Mass. 02168						X		

Table 2. (continued)

	MANUAL						SEMI-AUTOMATIC	AUTOMATIC
	PORTABLE, DESK TOP	DRAWERS	TUBS	ROTARY & CARROUSEL	POWERED	POCKETS, ETC.		
Eryindex Products Corp. Wood Ave. Bristol, Pa. 19007						X		
Filing Equipment Bureau, Inc. 275 Congress St. Boston, Mass. 02210						X		
File-O-Fax Corp. P.O. Box 1676 Hertel Station Buffalo, N.Y. 14216				X				
Foto-Mem, Inc. 2 Marcer Road Natick, Mass. 01760								X
General Fireproofing Co., The 413 Dennick Ave. Youngstown, Ohio 44 [illegible]	X	X	X			X		
Globe-Wernicke Co., The Div. Sheller-Globe Corp. 1505 Jefferson St. Toledo, Ohio 43624		X				X		
Guide System & Supply Co., Inc. 5112 2nd Ave. Brooklyn, N.Y. 11232						X		
HON Co., The P.O. Box 820 Muscatine, Ia. 52761	X				X			
Image Systems, Inc. 11244 Playa Ct. Culver City, Calif. 90230								X
Information Design Inc. 3247 Middlefield Road Menlo Park, Calif. 94025				X				
Information Retrieval, Inc. 3370 E. Florence Huntington Park, Calif. 90255								X
Information Supplies, Inc. 899 Skokie Blvd. Northbrook, Ill. 60062	X	X	X			X		
Invincible Metal Furniture Co. 842 S. 26th St. P.O. Box 607 Manitowoc, Wis. 54220		X						
Joyce Record Systems, Inc. 142 Boardman-Poland Rd. Youngstown, Ohio 44512				X				
Kwik-File, Inc. 2833 Harriet St. Minneapolis, Minn. 55408	X							
LeFebure Corp. 308 29th St., N.E. Cedar Rapids, Ia. 52406		X				X		

Table 2. (continued)

	MANUAL						SEMI-AUTOMATIC	AUTOMATIC
	PORTABLE, DESK TOP	DRAWERS	TUBS	ROTARY & CARROUSEL	POWERED	POCKETS, ETC.		
Lit-Ning Products Co. 10899 Wilshire Blvd. Los Angeles, Calif. 90024	X					X		
Lundia, Myers Industries, Inc. 224 W. Cerro Gordo P.O. Box 309 Decatur, Ill. 62525		X						
Lyon Metal Products, Inc. 57 Railroad Aurora, Ill. 60507		X						
Master-Craft Corp. 831 Cobb Ave. Kalamazoo, Mich. 49001						X		
McMillan Book Co., Inc. 128 Spencer St. Syracuse, N.Y. 13201						X		
Mead-Hatcher Assoc., Inc. Buffalo, New York 14216	X	X						
Mohawk Industrial Laboratories, Inc. 1 Ward St. Vernon, N.Y. 13478							X	
Monarch Metal Products, Inc. MacArthur Ave. New Windsor, N.Y. 12550	X	X	X			X		
Mosler Systems Div. American Standard Co. Hamilton, Ohio 45012		X		X	X			X
Myers, Ray, Corp 1302 Main St. Endicott, N.Y. 13760	X	X						
National Blank Book Co. P.O. Box 791 Holyoke, Mass. 01040						X		
National Cash Register Co. Main and "K" Streets Dayton, Ohio 45409		X				X		
National Fiberstok Corp. 2801 Grant Ave. Philadelphia, Pa. 19114						X		
Neumade Products Corp. 720 White Plains Road Scarsdale, N.Y. 10583		X						
Ochman, Edward, Systems P.O. Box 141 Fairfield, Conn. 06430	X	X	X			X		
Oxford Pendaflex Corp. Clinton Rd. Garden City, N.Y. 11530						X		
Peerless Steel Equipment Co. Unruh & Hasbrook Ave. Philadelphia, Pa. 19111	X	X						

Table 2. (continued)

	MANUAL						SEMI-AUTOMATIC	AUTOMATIC
	PORTABLE DESK TOP	DRAWERS	TUBS	ROTARY & CARROUSEL	POWERED	POCKETS, ETC.		
Pierce, L. W., Co., Inc. 250 West Chester Pike Havertown, Pa. 19083				X	X			
Post, Frederick, Co. Box 803 Chicago, Ill. 60690						X		
Posting Equipment Corp. 1721 Elmwood Ave. Buffalo, N.Y. 14207	X	X						
Randomatic Data Systems, Inc. 344 W. State St. Trenton, N.J. 08618							X	
Records Security Corp. Logansport, Ind. 46947		X						
Remington Rand Office Systems Division Sperry Rand Corp. 107 Putnam St. P.O. Box 171 Marietta, Ohio 45750		X		X	X	X		X
Retrieval Control Systems, Inc. 153 Allen Blvd. Farmingdale Long Island, N.Y. 11735			X			X		
Reynolds & Reynolds Co., The 800 Germantown St. Dayton, Ohio 45401						X		
Robins Data Devices, Inc. 15-58 127th St. Flushing, N.Y. 11356						X		
Royalmetal Corp. 1 Park Ave. New York, N.Y. 10016		X						
Sanders Associates, Inc. Daniel Webster Highway, South Nashua, N.H. 03060								X
Saunders Mfg. Co., The P.O. Box 243 Winthrop, Me. 04364						X		
Shaw-Walker Co., The Muskegan, Mich. 49443	X	X	X			X		
Singbusch Co. 2222 W. Clybourn St. Milwaukee, Wis. 53233						X		
Smead Mfg. Co. 600 E. 10th St. Hastings, Minn. 55033						X		
Smith, Jay, Inc. 292 State St., East Westport, Conn. 06880						X		
Stationers Loose Leaf Co. 246 E. Chicago St. Milwaukee, Wis. 53201						X		
Steelcase, Inc. 1120 36th St., S.E. Grand Rapids, Mich. 49508	X	X	X			X		

Table 2. (continued)

	MANUAL						SEMI-AUTOMATIC	AUTOMATIC
	PORTABLE, DESK TOP	DRAWERS	TUBS	ROTARY & CARROUSEL	POWERED	POCKETS, ETC.		
Supreme Equipment & Systems Corp. 170 53rd St. Brooklyn, N.Y. 11232		X						
Systems Manufacturing Corp. 13 Broad St. Binghamton, N.Y. 13904	X	X	X			X		
Tab Products Co. 633 Battery St. San Francisco, Calif. 94111	X	X	X			X		
Tallman-Robbins & Co. 2200 W. Devon Elk Grove Village, Ill. 60007						X		
Tape-Stor Division International Computer Appliances Corp. 200 N. 3rd St. Minneapolis, Minn. 55401		X						
United States Tabulating Binder Corp. 7207 Malvina Ave. Niles, Ill. 60648						X		
Univac Salt Lake City 322 North 21st. West Salt Lake City, Utah 84116								X
University Microfilms, Inc. 300 N. Zeeb Road Ann Arbor, Mich. 48106		X						
Visible Computer Supply Corp. 9865 Derby Lane Westchester, Ill. 60153	X	X				X		
VISIrecord, Inc. 54 Railroad Ave. Copiague, N.Y. 11726			X	X	X	X		
Visu-Flex Co. 633 S. Carondel[illegible] St. Los Angeles, C[illegible] 90057		X						
Vue-Fax Systems Controls Corp. 84 New York Ave. Westbury, N.Y. 11590						X		
Wallach & Associates, Inc. P.O. Box 18167 Cleveland, Ohio 44118		X						
Wassell Organization, Inc. 25 Sylvan Road South Westport, Conn. 06880	X			X	X	X		
Watson Mfg. Co., Inc. Furniture Systems Div. 53 Taylor St. Jamestown, N.Y. 14701		X	X					

Table 2. (continued)

	MANUAL						SEMI-AUTOMATIC	AUTOMATIC
	PORTABLE DESK TOP	DRAWERS	TUBS	ROTARY & CARROUSEL	POWERED	POCKETS, ETC.		
Weis Mfg. Co. Div. Sheller-Globe Corp. Toledo, Ohio 43612	X							
Wheeldex, Inc. 1000 N. Division St. Peekskill, N.Y. 10566		X		X	X			
Wilson, H., Corp. 555 W. Taft Drive South Holland, Ill. 60473						X		
Wilson Jones Co. 6150 Touhy Ave. Chicago, Ill 60648	X							
Wright Line Div. of Barry Wright Corp. 160 Gold Star Blvd. Worcester, Mass. 01606	X	X	X			X		
Yawman & Erbe Division Sterling Precision Corp. 1099 Jay St. Rochester, N.Y. 14603		X						

Table 2. (continued)

PART V

CURRENT SIGNIFICANT RESEARCH SURVEY

1. INTRODUCTION AND SUMMARY

This survey provides indications of current research activities, prototype equipment and system developments, and trends of interest to microfiche users and systems managers. Specific attention has been given to identifying current research activities in the area of microform storage and retrieval that might negate the development of present equipment and alter existing trends. Information was gathered and interpreted from three major sources:

a. Personal contact with and use of professional colleagues, manufacturers' representatives, salesmen, and consultants.

b. Review of related periodical literature, books, and monographs.

c. Examination of equipment and specifications over a period of several years.

Consideration was given (1) to microfiche information retrieval systems; (2) to microfilm and reprographic processes and developments; (3) to other technologies, including computer data processing systems, library developments, information storage and retrieval in education, business, and science, and information transfer developments.

The information is presented in two parts:

a. Paragraph 2 considers significant developments that can be utilized within 12 to 24 months.

b. Paragraph 3 considers potential developments that will most probably become usable in the next 2 to 10 years.

Interpretation of the developments and activities described in paragraphs 2 and 3 lead to the following conclusions:

a. Present microfiche systems and devices will be affected greatly by utilization of tab size, 3 x 5 inch size, and 8 x 10 inch size microfiche, and by use of reduction ratios in excess of 20X and 24X.

b. Development of such techniques as optical storage media, wide-band transmission, holographic reproduction methods, and others can materially alter present cost-benefit relationships that currently lead to increased utilization of conventional microfiche.

c. Development of on-demand publishing can materially impact on existing information center and microfiche dissemination centers operations and methods. This applies directly to future operations of DDC.

2. SYSTEMS AND PRODUCTS IN PRODUCTION DEVELOPMENT

In this section, we shall be considering systems and products which have been developed sufficiently that they can reasonably be expected to become available within 12 to 24 months. The usual product development and marketing changes can be expected to affect the time tables.

2.1 INDEXING APPROACHES

2.1.1 Personalized Index. The capability now exists to develop indices tailored to meet individual user requirements, as specified by the user. Generalized programs for creating and maintaining indices have been developed which provide for processing of multiple files, or multiple indices during any one pass. Thus personalized indices can be economically created and updated. The individual indices may be combined on a periodic basis to form indices for information centers or libraries. A batch processing approach would be used, although input could be from terminal. These programs can be produced to run on medium-scale computers, or larger, and may become available either on a program-lease basis, or on a contract basis, per index or per year.

2.1.2 Online Browsing and Ordering. Several systems have been developed and are available to provide an online browsing and search capability to permit identifying documents of interest, and to obtain corresponding accession or document numbers. The capability also exists, or can be developed to provide an ordering capability whereby the ordering function can be performed automatically upon command, within the browsing and search program. For example: ALPS (Automated Library Processing Services), ORBIT II (Online Retrieval of Bibliographic Information Time-shared).

2.2 MICROFICHE READER REDESIGN

Several approaches are currently being explored to improve the reading quality, and handling capabilities of microfiche readers. The approaches vary as to when orders will be solicited. However, they are expected to be marketed in late 1970, or mid-1971.

2.2.1 Fiche Cartridges. At least three manufacturers are currently attempting to develop cost-effective approaches to fiche cartridges. Techniques range from manual loading of the cartridges which would have a capacity of 10 to 100 fiche, to larger capacity fiche with fully-automatic handling. The fully-automatic handling systems appear to have cost problems.

Image Systems "CARD" unit is expected to be modified so as to accept plastic boxes, or cartridges, of 45 fiche each. The cartridges will be interchangeable. Cartridge identifications and fiche positions would be stored within the computer, for computer-controlled systems, thus permitting identification of the cartridge, and location of fiche within the cartridge.

The manual cartridges appear to have been started in development after the more automatic approach, and may, therefore, take longer to reach the market. Two different approaches seem to have been considered: (1) the cartridge would operate similarly to current 35mm slide projectors, and would require

a mount of some kind to obtain necessary rigidity for handling, or (2) the cartridge would operate somewhat similarly to Kodak's Dekastrip, in which one of ten fiche would be extended from the case into the viewer.

Use of the cartridge, regardless of type, would seem to require a change to the reader, particularly to the fiche holder. The present optical systems could permit modifications of the fiche carrier, without requiring modification to the projection system or to the screen.

The manual fiche cartridge concept appears to offer greater utility and growth capability than present circular drum systems, because of the limitations on capacity now existing in the present Image Systems' CARD system, and in the Cytek MIRS equipment.

2.2.2 Improved Fiche Carriers. Efforts are being made to improve the fiche carriers currently used in microfiche readers. The effort is two-fold: (1) to develop detent mechanisms that could be used in influencing manual travel of the carrier by sensing the stopping position for the next image to be viewed, and (2) to incorporate servo motors to drive the fiche carriers along x and y axes so as to permit pushbutton advance.

Automated fiche carriers are particularly useful in connection with fiche cartridges.

2.2.3 Human-Engineered Readers. Attempts are being made to improve reader image quality and flexibility. Curved screens have been introduced by Dioptrix and others to reduce glare, hot spots, and impact of ambient light on the screen. Other efforts are being made to design readers that can be placed on a desk or table, and that are much lower in height than current readers. Such readers would allow the user to look down at the screen instead of straight at a screen, as is the usual practice.

Currently under development is a reader with separated screen which utilizes a beam splitter technique. When operating, the light beam passes upward through the film plane and lens system and into a prism (beam splitter) mounted at user eye-level. A portion of the light exits the front of the prism directly into the eyes of the user. The remaining light exits the rear of the prism toward a screen positioned several feet behind the device. The image reflects off the screen, back through the prism and into the user's eyes. The screen provides a very narrow reflectance angle, which reduces the light drop. Hot spots, ambient light problems, and screen size limitations are reduced by this principle. The non-critical optical path of the beam splitter permits use of multiple lenses of extreme differences in magnification. Thus, the same reader can be used for 18X, 85X, or 150X lenses, for example. And, if the screen is sufficiently far from the beam splitter, full page images may be read of COSATI fiche, even when using the 150X lens. Again, the capability of substituting different microfilm carriers permits using microfiche, cartridges, ultrafiche, and aperture cards with the same reader.

At least two companies are exploring the possibilities of simultaneously projecting two or more images from a microfiche onto a screen. A Graphic Comparator was introduced in 1966 by DASA Corporation, to compare images on two aperture cards. Discrepancies between the images appear in color, overlapping images appear white. The newer devices would permit generation of color from two black and white images, or the display of information from two different microforms, such as 16mm roll film and microfiche.

2.3 RETRIEVAL AND REFILING

Current efforts in the area of retrieval and refiling of microfiche appear to be very limited. The use of random-access devices such as Randomatic, Mohawk 400, or Access 60 for microfiche has been limited because of the lack of stiffness of microfiche. Access Corporation is attempting to adapt its unit to fit into a Diebold power file, thus providing power drawer selection, and random search through the selected drawer.

Some effort is being expended into combining microfiche with an eye-readable index to the contents of a particular fiche. Indications are that the approach will not be aggressively developed or marketed unless monetary support is forthcoming. A probable cause for the apparent limited effort in the random access area is that there is not really a market of sufficient magnitude for these devices to warrant research and development money. There is a strong suspicion that serial filing of fiche is effective for most files under one million items, and that the basic problem is identification of individual items to be extracted from the files. Again, refiling appears sufficiently accurate, and cost-effective as to limit the market for random-access devices. If, however, random-access files are coupled directly with a viewing capability, the economic size of the market may change.

2.4 HARD COPY CAPABILITIES

Improved hard copy capabilities through new reader-printers, lower cost materials, and new techniques appears to be imminent. Much developmental work is being done; product development is underway; announcements, rumors, and promises have been given--product availability is not known. Because of the strength of the talk, however, we will discuss some of the promised capabilities.

2.4.1 Automated Printout. Two companies are rumored to have an automated print capability allowing a fiche to be converted to hard copy with minimal personal intervention. Neither one apparently will allow for designating a starting and stopping position for printout other than the first and last images of a conventional fiche. Printout may be electrostatic, or may be by a totally new process.

The 3M dry silver paper currently used in the Executive I reader-printer, in cut-sheet form, can be expected to be made available in roll form, as soon as competition in the low-priced reader-printer field becomes a reality.

Eastman Kodak has announced the Motormatic Reader-Printer for roll and cartridge film, and for microfiche. The unit utilizes a roll of paper, and provides print costs on the order of 3 to 5 cents per copy.

Some reduction of electrostatic print costs can be expected with improvements in the market for such reader-printers. It is not known whether any manufacturer is attempting to develop a downward-projecting reader that can be used with a flatbed printer, such as the Xerox 2400, to provide direct imaging onto the selenium drum. The concept is within the realm of possibility, at least.

2.4.2 Polarity Change. Presently, Xerox offers the capability of changing polarity on a reader-printer. The polarity can only be established at the factory. Minolta and DASA have introduced units providing a switchable output, allowing for black-on-white printing from positive film, and black-on-white printing from negative film. Other manufacturers can be expected to match the capabilities within a reasonable time period.

2.4.3 Copyright Laws. Present copyright laws presumably protect the holder from hard-copy printout from fiche images. The laws are as effective for fiche, as they are for paper copies, with copiers. Congress is expected to establish a copyright revision bill within two to three years that may resolve the conflict.

2.4.4 Controlled Degradation. Work is actively being pursued on processes whereby the printed image will become illegible within a 24-hour time period. This is particularly effective when attempting to ensure the currency of information by control of the original film, but where prints of the film may be retained outside of the control point. For example, in a maintenance system for aircraft, the mechanics often make prints of a document to be used at that time. The mechanics sometimes retain the print, which has been marked up, perhaps, and to use that print, rather than to request a new print from the current film.

2.5 DUPLICATING CAPABILITIES

Present capabilities to duplicate one microfiche on another piece of film appear adequate in terms of capacity, image quality, ease of operation, simplicity. The present duplicating equipment remains somewhat more costly than seems needful, and requires either more expensive film, usually vesicular, or special handling for diazo film, since it is developed by ammonia fumes.

It seems likely that the trend toward development of new duplicating films, such as Xidex, will continue. Costs or convenience of use or both may be expected to change accordingly. It also seems likely that films with new capabilities, such as diazo films that can be viewed, but not contact printed, can be expected. Presently, Bruning and Teledyne have shown such a non-duplicating film.

Film manufacturers are attempting to provide a non-printable film that can be viewed only by authorized users. One approach used by Technical Operations, Inc. provides for use of a screen filter. The viewing equipment would permit neutralizing the screen, while non-authorized use would be infeasible on most viewing equipment, since the screen would not have been neutralized, thus not allowing the image to be seen.

One manufacturer is expected to bring out a thermoplastic film which can be overwritten, after initial exposure. The image would be indicated as obsolete by means of the overstrike. Work on erasable films have not yet progressed beyond the laboratory stages.

3. NEW DEVELOPMENTS

Technological innovations that have been announced, and, in some cases, scheduled for implementation and sale, may affect the current cost-benefit analyses of COSATI microfiche information retrieval systems. Consequently,

these developments must be considered when evaluating current alternatives, and before implementing major system improvements, so as to ensure that the proposed changes will not have been obsoleted before they can have justified their costs.

Forecasting the life cycle of products, designs, and systems is an inaccurate process at best. When attempting to do so for a variety of products and techniques the reliability factor becomes even lower. Consequently, the descriptions attempt to show only what may be available, and the functions expected to be performed at some time during the next 2 to 10 years. Other products/systems may appear in place of, or along with the ones selected for inclusion in this section. The major thrust, however, has been directed towards information handling, rather than towards document handling. Present systems provide essentially for transference of documents, books, or other formal, conventional packages. Systems and products of the future can be expected to cope more directly with information and concepts, while retaining the capability of handling documents.

3.1 COMPUTER AND MICROFILM INTERACTION

The use of computer-output-microfilm (COM) devices is increasing at a very rapid pace. Estimates have been made that from 25-40% of all computer output, including present manual generation of text type documents, will be by COM by 1975. By 1972, up to 5,000 COM units may be in use, as compared to the 700 or so estimated to be in use as of the end of 1969.

Computer-input-microfilm (CIM) devices are just beginning to become available. These devices provide a means of digitizing microfilm images, so that the images may be used either as a computer-input device, or for subsequent processing, computer modification, and computer output of microfilm images. The input process may convert the film characters to binary characters through optical character recognition techniques, or may convert the images to digitized graphical information, or gray scale representations.

Computer-controlled retrieval devices using external files are in use today in the fully-automated systems, such as CARD or Mosler Selectriever. Computer-controlled retrieval from central files of optical storage with conversion to meaningful data strings in machine language is less available. Foto-Mem has developed a prototype system of a binary-coded and optically stored information system, utilizing photocards. The Project Intrex retrieval system provides for retrieval of microfiche in a central file for display and online inspection/reading at remote locations. Other systems have been considered, or are under development, which combine optical storage with computer switching and facsimile transmission.

3.2 FACSIMILE TRANSMISSION

Present capabilities of facsimile systems relate primarily to hard copy input, but microfilm images can be used. Transmission times for a standard 8 1/2 x 11 page over conventional telephone lines are now about six minutes. Through data compression techniques, conditioned lines, or wide-band transmission channels, transmission times can be reduced to as little as 10 seconds. Cost and reliability of the recorders and reproducers are becoming more favorable. Systems using a centralized optical storage system are dependent on a form of facsimile transmission for remote access. The merging of facsimile and message-switching systems appears most probable. Current estimates are that by 1975, most homes and offices will be equipped with wide-band transmission lines, using either microwave or cable networks.

3.3 RECORDING DENSITIES

Present reduction standards for microfiche of 20X were based in part on available photographic techniques, using planetary cameras. New developments, including computer-output-microfilm, laser recording, and two-step processing with photochromic and conventional photographic techniques, provide a capability for increasing packing densities on microfiche to encompass four ranges of storage.

3.3.1 Low-range. Conventional microfilm reductions of from 4 to 38X. Capacities of microfiche would range up to a maximum of about 120 pages. The low range may extend to 42X, since computer-output-microfilm recorders appear to be able to operate at that reduction effectively. 42X should provide close to 250 pages per fiche.

3.3.2 Mid-range. Reduction ratios of from 35 to 90X would provide up to about 900 pages. Present COM equipment provide the capability of generating microfiche at reduction ratios of 42-48X. This provides a claimed maximum of 450 pages. Indications are that the 50-90X range will be widely adopted for text documents, books, etc. Encyclopedia Britannica has adopted that range for its Library of American Civilization, to be published on microfiche. At least one other company has elected to use that range for its planned book publishing effort.

3.3.3 High-range. Currently referred to as Ultrafiche. Reduction ratios of from 90 to 210X provide capacities up to about 2,000 pages per fiche. Current film limits are estimated at about 280X, or just under 3,000 pages per fiche. The high-reduction range to data has not proven to be attractive to a large number of potential users. This may change, as quality, price, and availability of equipment improves. The high-reduction fiche competes directly with cartridge film and with magnetic memory devices.

3.3.4 Extreme-range. Reduction ratios from 280X to 1,000X or even higher. Capacity has been estimated at up to 10,000 pages per inch. Recording densities in this range can only be achieved by laser recording, bubble techniques, or other exotic laboratory techniques. These techniques may be used only for computer memory devices, or, possibly, for information retrieval devices.

3.4 MICROFICHE SIZES

The COSATI microfiche size of 105 x 148.75 mm, or approximately 4 x 6 inches, has been the approved standard size for Government-produced microfiche since 1964. It has been accepted by the United Nations, by the National Microfilm Association, and others. But, new products and new systems are being introduced and strongly supported that provide for a size other than 4 x 6 inches. For example, NMA and ANSI support, in addition to the 4 x 6 inch size, a 7 x 3 inch (Tab card) standard. Considerations of sizes other than the COSATI standard are presented below.

3.4.1 Tab Card. Several commercial users have been actively supporting the tab-card size microfiche (7.375 x 3.250 inches) for the following reasons:

a. I.B.M. uses the tab-card size because of their punch-card files, retrieval equipment, and orientation.

b. Boeing Aircraft Co. is using the tab card for the Boeing 747 support documentation because it provides a means of combining 35mm film of engineering drawings, with 16mm film of specifications and other text material.

c. Mosler and others recommend use of tab-card fiche because of the superior handling of tab-card size material over the conventional 4 x 6 inch size for mechanized handling.

3.4.2 3 x 5 Inch Card. Encyclopedia Britannica has selected this size for the Library of American Civilization Series. The fiche can be put into envelopes, and filed within the standard catalog card file, with the catalog information on the envelope.

3.4.3 Full Page Fiche. Efforts have been and are being made to utilize an 8 x 10 inch fiche, or equivalent in one of two ways. First, the full-page fiche would be used so as to store very large collections of information at ultrafiche reduction ratios. Secondly, the full-page fiche concept allows for indexing individual images, putting normal-reading images--indexes, key-words, etc.--on the lower-half of the fiche, while the corresponding image in reduced form is visible on a reader. NCR and others have attempted to develop effective systems. It is doubtful that the full-page fiche will be an effective medium until readers are developed that are about book size, thus allowing reading of book size fiche in a book-sized container.

3.5 FORMATS

Reading tests seemingly indicate that vertical reading for microfiche is more effective than horizontal reading. Thus, if the images were arranged cine fashion, so that pages were read vertically along the 6-inch dimension, there would be 5 rows of 12 images, scanned vertically. Atlantic Microfilm has proposed the vertical fiche, in which there would be 12 rows of 5 images each, suitable for computer printout, although the 5 x 12 cine concept seems more effective. Suggestions have also been made regarding employment of alternate reading sequences (e.g., boustrophedon, spiral). However, to date, no publications have been announced using such formats.

Present capabilities for handling oversize pages in microfiche require turning the image sideways. COSATI specs provide for normal reading layout only. Many COSATI fiche are produced with the side-reading pages. The specifications or the fiche filming should be modified to agree with each other. Considerable effort is being expended in designing information packages, using conventional 4 x 6 microfiche, but adjusting the image placements and movement from image to image to enhance the transfer of information, rather than to maintain the page-reading concept presently employed. If human factors research efforts result in measurable improvement in reading speed or comprehension, or reduction of fatigue, then COSATI fiche may require a corresponding change.

3.6 ON-DEMAND PUBLISHING

Increasing emphasis is being placed on providing individual selection of segments of computer-stored documents, and subsequent combining and publication of the selected segments. Publishing may be accomplished in either microform or paper copies. Associated Press, Encyclopedia Britannica and others are using or developing systems employing the approach.

3.7 REPROGRAPHIC CHANGES

New developments in electrostatic printing, in electrophotographic processes, and in organic photoconductors provide increasing capabilities to develop graphic-arts quality, high-speed non-impact printing, which matches COM devices in output speed. The use of printing processes at electronic speeds with on-demand publishing presents system development opportunities for large-store systems.

3.8 OPTICAL STORAGE FILMS

New photographic and storage films are being developed which provide for a wide range of new or expanded capabilities. The films include improved silver-halide films, but also include organic films, dry silver films, vesicular films, diazo films, and others. Some capabilities expected include:

3.8.1 Non-reproducing Films. Duplicating diazo films have been developed by Bruning and others that cannot be contact-printed. Thus, copyright materials can be disseminated in microform, with reasonable security against illegal duplication.

3.8.2 Erasable Films. Several companies, including Xerox, General Electric, and others are working on thermoplastic and other films that can be erased and rerecorded. At least one company is expected to be marketing a film that can be overwritten after development, so as to permit purging of obsolete information.

3.8.3 Multiple-layer Films. Processes and equipment are being developed to allow layers of images to be recorded on the same frame of a film. The viewing equipment focuses on a single layer, for one set of information, or on a composite of layers, for several sets of information. For example, a multiple-choice question sheet is recorded on one layer. The answers are recorde on a second layer. The student can view the questions, then see the correct answer

3.8.4 High-resolution Films. New films are being developed, similar to Kodak's Lippman Film, with a resolution capability in excess of commonly-used films. The high-resolution films will permit packing densities several orders higher than presently available.

3.8.5 Faster Films. New films are being developed that can react to the lower light levels of electronic displays, and with reduced exposure time requirements such that filming can be done at high rates of speed, compatible with computer speeds.

3.9 ELECTRONIC DISPLAYS

CBS, RCA, Matsushita Electric and AT&T, to name just a few, are developing tape units and display systems (picturephone) which can be hooked into a television set, for playback, or into a computer or other device for interactive communication. The advent of home display of prestored magnetic or optical information may have a major impact on types and aspects of information transfer.

It is conceivable, although not probable, that electronic display systems can be utilized exclusively for information transfer, and that the requirement for microfiche dissemination of reports will no longer exist. It is likely, however, that electronic display system developments may impact on microfiche production methods, on the collection of documents to be micropublished, and on the transmission of such documents.

PART VI

SYSTEM DESIGN OBJECTIVES AND SPECIFICATIONS

1.0 INTRODUCTION AND SUMMARY

This section presents a detailed description of a recommended set of design objectives and specifications for a low-cost microfiche storage and retrieval system. Included, is a discussion outlining alternative designs and considerations underlying the selection of each recommended design. Designs considered herein vary in the degree to which they are applicable to the requirements of DDC/DoD small users as defined earlier in this report. The recommended systems described in this section fulfill the greatest number of specific user requirements than any of the other alternatives considered. As such, each is recommended for use by specific categories of larger, more active DDC users. They are not recommended for all DDC/DoD small users.

2.0 SYSTEM CAPABILITIES

The following is a discussion of the design considerations and desirable equipment capabilities related to each of several functions which are a part of or are closely related to a microfiche storage and retrieval system. Functional areas considered are search, storage, retrieval, viewing, reproduction, duplication and file integrity and security. In the most basic type of storage and retrieval equipment, functions are limited to storage, retrieval and, to varying degrees, security. More complex equipment may include one or more of the other functions listed above as on-line features. Each is considered here to provide a basis for development of selection criteria.

2.1 SEARCH FUNCTION

This function involves searching indexes in order to determine or identify which fiche are desired for retrieval. An automated storage and retrieval

device may or may not include the search function as one of the features of the equipment. When it does not, the searching is performed using external indexes in the form of card catalogs, book catalogs, computer-based indexes, other appropriate devices. These external indexes are used to determine the unique identifier used in the automated retrieval function.

When the search function is included in the design of an automated storage and retrieval device, the index is built into the system and permits retrieval of individual or whole categories of fiche by descriptors or combinations of descriptors in addition to the unique identifiers (if any) of the individual fiche. In a library type of operation, the chief advantage of index automation would be in its application to subject indexing. Subject coding individual fiche in storage would facilitate retrieving documents on a given subject in much less time and with much less labor than is usually consumed using manual search techniques.

Two serious disadvantages exist, however, with regard to building the search function into the design of an automated storage and retrieval device.

First, because automated or built-in indexes usually feature batch retrieval of whole categories of microfiche, compatibility with other on-line features (such as viewers or duplicators) is not possible, at least not at a reasonable cost. Simultaneous handling of multiple fiche, e.g., retrieving, transporting and automatic loading and unloading of on-line output devices, requires far more complex and costly equipment than does the handling of single fiche.

Second, the amount of index data which can be stored on individual microfiche using techniques within the present state-of-the-art is relatively small. A variety of notch or pin-hole coding techniques exist which permit the recording of up to nine or ten alphanumerics which, in terms of most library requirements, is far short of the amount of data

needed for a reasonable degree of retrieval selectivity. Such a coarse degree of selectivity would result in retrieval of excessive numbers of microfiche containing many documents not relevant to the user's interest.

These advantages and disadvantages must be considered in the development of a design for a microfiche storage and retrieval device. The merits of a rapid, though limited, retrieval-by-descriptor capability must be weighed against the merits of having viewers, printers, duplicators and other equipment on-line at a reasonable cost.

2.2 STORAGE FUNCTION

Design considerations related to microfiche storage include the size, shape and capacity of the storage device, and the extent to which available storage space is on-line or off-line with respect to the automated retrieval function.

Size, shape and capacity are inter-related. Determining what combination of the three is optimum involves consideration of many variables. In general, size should be small, capacity should be large and shape should be functional and pleasing to the eye. More definitive terms must be stated, of course; and these must be derived from an analysis which begins with the following examination of microfiche itself.

A single microfiche is a piece of film approximately 4" wide, 6" long and .008" (or 1/125th of an inch) thick. Packed tightly together, a linear foot of microfiche contains 1,500 individual fiche. 10,000 microfiche packed solidly would fill a 6 1/2 foot long tray. 100,000 would require a 65 foot long tray. These figures only suggest the <u>minimum</u> storage space requirements. In practice, stored microfiche requires more space than is indicated by these "tightly packed" figures. Any retrieval system, even manual, requires that friction between surfaces of adjacent fiche in a stack be minimal and this introduces the requirement for an air space. Determining how much space is sufficient is a

problem compounded by the fact that microfiche has poor dimensional stability, that is, it shrinks, swells and warps. Spacing sufficient for storage and retrieval of paper materials, for example, TAB cards, (which has much better dimensional stability) would probably not be sufficient for microfiche. Warpage or buckling is the most troublesome design problem. (Federal microfiche standards presently allow warping up to 0.25" from a base plane. See PB 167-630, Federal Microfiche Standards, COSATI, 3rd Edition, April 1968, pg 2.)

The storage equipment designer can consider several alternatives. One, affect or hope for a change in the standards. Two, design equipment which provides large clearances between stored fiche (e.g., a clearance of .050"--which still may not be enough. At this clearance, 10,000 fiche would require a tray 48 feet long). Three, attach a stiffening strip or the equivalent to one edge of each fiche to reduce warpage and provide at least one straight edge for mechanized handling. Or four, use a "positive grip", retrieval technique which is not affected by a reasonable amount of friction between fiche surfaces.

A combination of the third and fourth alternatives would appear to be the best approach. Assuming that both can be done (discussed later), this approach suggests that a clearance not unlike that found in several successful paper storage and retrieval systems (approx. .010" spacing between cards) is technically feasible for microfiche applications. Further engineering analysis is required on this point, but for purposes of discussion, .010" nominal clearance will be accepted as an optimistic estimate upon which further calculations can be based.

10,000 microfiche packed with .010 clearance will fill a tray 15 feet in length.

The question is then raised, is a top capacity of 10,000 good enough? Should a "modularly expandable" system be capable of expanding beyond a 10,000 limit?

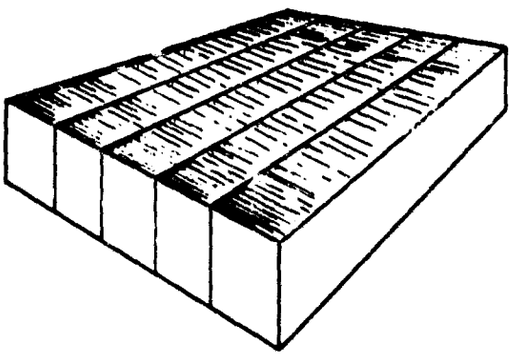
In view of the growth anticipated in the microfiche collecting of DDC/DoD users over the next several years, as well as the possibility of exceptional growth

in certain user categories, 10,000 will probably be an adequate limit for certain types of users, specifically, bench-level types. For larger organizations, such as libraries and information centers, 20,000 emerges as a reasonable system capacity. This figure represents a limit which will accommodate the growth of a large majority of DDC users in the 1970-75 period. It also falls within the realm of design/cost feasibility, as will be discussed.

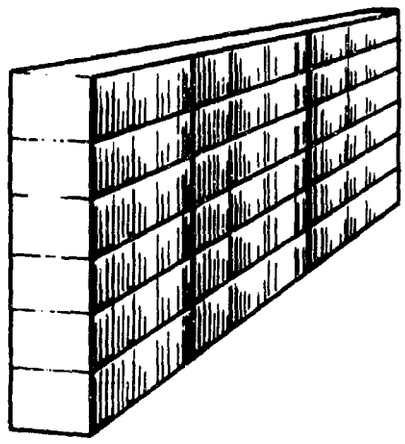
2.2.1 Basic Shape-Size Concepts

20,000 microfiche packed with a .010" clearance would require approximately 30 linear feet of tray space. There are a number of ways to arrange 30 linear feet of tray space (other than in a single straight line). Keeping in mind that for purposes of retrieval at least one edge of each fiche must be accessible, the 30 feet can be divided into segments and arranged as follows:

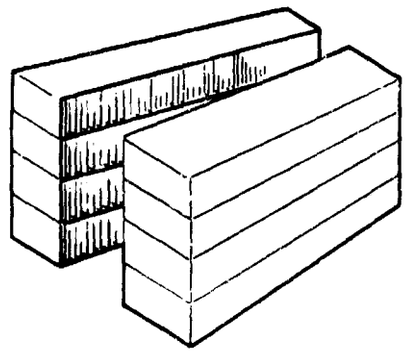
a. Arranged flat, side by side. Microfiche could be ejected or withdrawn from either the top or the bottom of the bed.



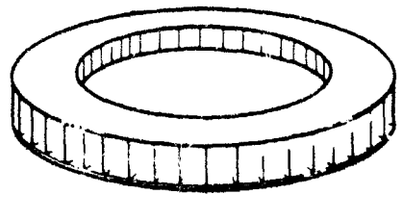
b. Arranged vertically in a single stack. Microfiche could be ejected or withdrawn from either side.



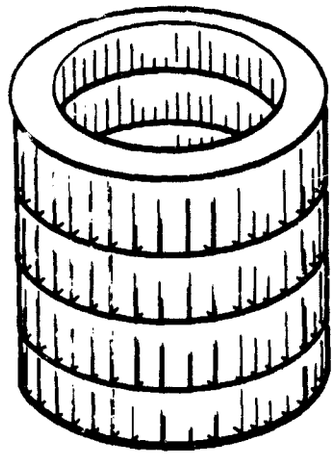
c. Arranged vertically in two stacks with a space between. Microfiche could be ejected or withdrawn toward the center space.



d. Bent into a 30' circle. Microfiche could be ejected or withdrawn from any side, top or bottom.



e. Each segment bent into a circle and stacked vertically. Microfiche could be ejected or withdrawn from the inside or outside of each circle.



From the standpoint of compactness, efficiency and design versatility, arrangements c. and e. above offer the greatest promise. The double stack efficiently stores the greatest number of rectangular objects in the smallest most compact rectangular space (considering additional space required for retrieval mechanism). The cylindrical arrangement of carrousel shaped trays is not quite as compact but does offer a greater degree of flexibility in the design, operation and growth of this overall system, as will be discussed.

Another consideration related to the storage function regards the extent to which available storage space is on-line or off-line with respect to the automated retrieval function. On-line storage can be rapidly accessed and generally provides maximum convenience to the user. Off-line storage in most systems is in trays, carrousels or other containers which must be manually installed in the automated retrieval device before retrieval can occur. Off-line storage obviously is less convenient, but it is also less expensive. Larger capacity systems can be built if a percentage of the collection is in off-line storage, than could be built at comparable expense when <u>all</u> storage is on-line.

The equipment designer must consider the nature and organization of the collection and the way in which it will be managed to determine how much,

if any, of the total collection is storable off-line. Library-type collections which consist of a wide variety of documents all of which presumably are valuable and subject to eventual retrieval, tend to be sufficiently convenient to the user only if they are stored on-line. In a library, if microfiche is stored off-line, loading it into the automated device usually requires more time and effort than if the storage and retrieval activity were manual to begin with.

2.3 RETRIEVAL FUNCTION

This function involves the physical removal of fiche from storage.

In fully automated storage and retrieval systems, fiche is transported mechanically from its position in storage to a second position where it may be viewed, duplicated or completely ejected from the storage contained. Auxiliary equipment such as viewers, printers and duplicators are on-line, loading and unloading is automated, and each is considered an integral part of the storage and retrieval system.

In semi-automated storage and retrieval systems, retrieval is manual. Selection is automatic, but the fiche are physically removed from their location in storage by hand. (Selected fiche are usually moved partially out of the stack so that they are easily seen and grasped by hand). Semi-automated systems usually permit selection of multiple fiche simultaneously, but do not, for reasons previously explained (see para. 2.1), permit other functions such as viewing, to occur on-line at a reasonable cost.

In the fully automated systems, several design considerations relevant to the retrieval subsystem include retrieval speed, simultaneous operations and physical handling.

Retrieval speed in small DoD facility operations is rarely critical. The relatively low hourly demand for documents in a typical facility (compared, for

example, to the hourly demand for data in a telephone company billing department) leaves human impatience as the only real basis for establishing a minimum acceptable speed for an automated retrieval system. In a manual operation, a customer is usually content to wait several minutes for a document to be retrieved and delivered to his hands. However, in an automated operation, a machine is expected to react within a few seconds after activation. The level of impatience felt by the user after any given period of time varies with his expectations (based on past experience with similar machines) and his disposition. In most cases, a delay of up to 6-8 seconds is tolerable. Impatience with delays in excess of 6-8 seconds can be reduced if the user is provided some type of intermediate signals or other indications assuring him that the machine is functioning and that progress is being made.

Simultaneous operation of the storage and retrieval system is usually desirable at DoD facilities. Users should be able to access microfiche storage while other users are reading, printing or performing other operations on-line. Design of the system should provide for maximum multiple user access on either a simultaneous or time-shared basis.

Physically handling or transporting microfiche by the retrieval subsystem can be accomplished by rollers, belts, mechanical holders, air currents, gravity, magnetic force, movement of the fiche container (tray, cartridge or carrousel) or any combination of these methods. Each method varies in the degree to which it induces physical wear on the transported fiche. Also, each method varies with respect to its reliability. The design of the retrieval subsystem should incorporate a transport mechanism which has minimum or no frictional contact on the emulsion side of the fiche image area. An adequate design would also provide for a minimum of fiche contamination from dust, lubricants and other foreign materials.

2.4 VIEWING FUNCTION

In a fully automated storage and retrieval system, reading of retrieved microfiche documents is usually conducted on on-line equipment. Microfiche are retrieved and read individually, in a sequence determined by the equipment user. Microfiche is normally not retrieved in multiples as this would involve complex buffering, queuing, ordering and selection mechanism which would increase the size and cost of a machine well beyond the net value of the additional capability.

Factors to be considered in the design of viewing equipment include overall size, weight and power requirements; screen size, angle, color and surface texture, image brightness, contrast, sharpness and magnification; frame advance, reverse and horizontal, vertical and rotary positioning; film format; maintenance requirements; and environmental factors such as operating noise and temperature. Each of these factors has been discussed in great detail in a variety of publications on the subject and will not be reiterated here. The reader is directed to the bibliography contained in this document. Specific recommendations relevant to each factor are detailed under Equipment Specifications (paragraph 5).

2.5 REPRODUCTION FUNCTION

Image reproduction can be an on-line feature of an automated storage and retrieval system. Normally it would be associated with a viewing device designed to print selected images, e.g., the print function of an on-line reader-printer. It can also be an independent function designed to reproduce one or more copies of whole documents.

Several methods for microfiche-to-hard copy reproduction presently exist, including a number of simple, dry copy processes which provide quality copies at a moderate cost and minimum maintenance.

Design considerations relevant to the reproduction function include unit size, weight, power requirements, warm up time, printing speed, reduction/enlargement ratio, copy quality, copy costs, maintenance requirements, noise and heat generation. Specific recommendations related to each of these factors are detailed under Equipment Specifications (paragraph 5).

2.6 DUPLICATION FUNCTION

The duplication function can be an on-line feature of an automated storage and retrieval system. A duplicator would provide duplicate copies of microfiche contained in the central file. Duplicates could be loaned or given away to individual users without disturbing the integrity of the central collection. A give-away policy would sometimes prove less costly to a library or information center than would loaning microfiche and would also facilitate the development of decentralized satellite files in individual user areas.

Factors to be considered in the design of an on-line duplicator include unit size, weight, power requirements, warm up period, minimum performance period, processing time, venting, film transport mechanism, maintenance, operating noise, operating temperature and fumes.

2.7 FILE INTEGRITY AND SECURITY

The design of a document storage and retrieval system can incorporate features which provide for varying degrees of file integrity or security. At one end of the spectrum are measures which simply discourage misfiling or other human errors. At the other extreme are measures which fully protect a file from any type of disturbance or unauthorized use.

An example of a system with a modest degree of file integrity is one which uses cartridges or the equivalent to store small groups of fiche. Cartridges are manually loaded onto readers and fiche are mechanically selected and viewed

inside the machine. There is no need for physical handling of individual fiche by the user at any time. Fiche are protected from soiling. Individual fiche are not likely to be misplaced. If cartridges are stored manually, they too are less likely to be lost or misfiled (because of size and probable design of storage rack). If cartridges are stored automatically, loss or misfiling becomes highly improbable. However, the cartridge system does not preclude theft or the possibility of misfiling if users disturb individual fiche when manually handling the cartridge.

Random-access storage and retrieval systems also afford a degree of file integrity. In this type of system, microfiche may be returned by hand to any location in the file, thus misfiling is impossible. No fiche will become "lost" within the storage device. However, these types of random-access systems do not prevent fiche from becoming lost outside the storage device. This system does not preclude theft or human forgetfulness to return fiche.

A higher level of file integrity is obtainable in fully automated storage and retrieval systems which have viewers and/or duplicators on-line. On-line equipment is loaded and unloaded automatically and the fiche never leaves the system. Human forgetfulness is negated and theft becomes less easy.

The file becomes even more secure when the system described in the preceding paragraph is housed in a secure cabinet and additional safeguards are employed. Added measures include special coding (e.g., notches) of classified fiche which will disable on-line printers and duplicators and/or provide a visual and audible signal to alert staff personnel when classified materials are being retrieved.

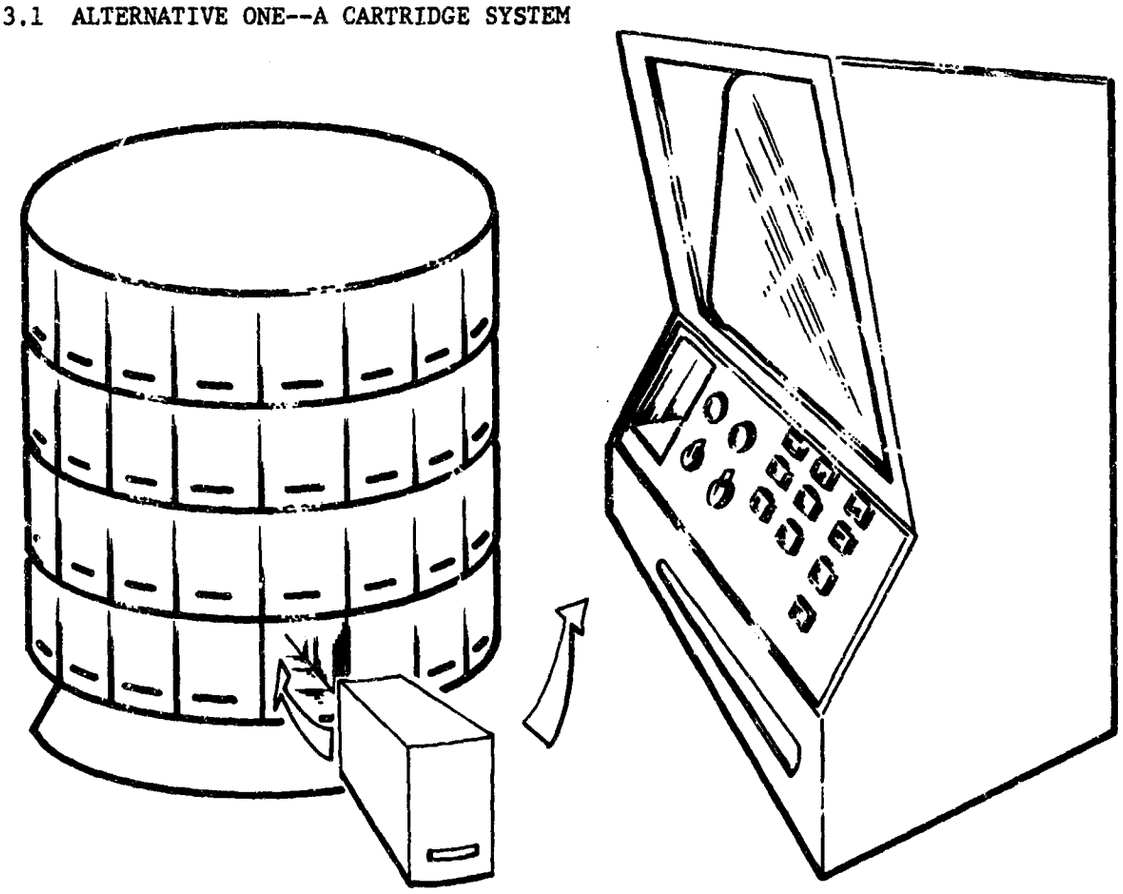
The equipment designer must consider the requirement for or the desirability of file integrity versus the additional complexity and cost of this feature in some systems. Alternatives to built-in file integrity include a variety of effective administrative procedures which can be employed to protect a file.

In some cases, especially with regard to classified materials, the administrative procedures may be required regardless of the equipment design.

3.0 ALTERNATIVE DESIGN CONCEPTS

Three alternative designs were postulated by SDC. Each satisfies to varying degrees the user requirements outlined in Part II of this report. Estimated equipment costs related to each design range from under $4000 to approximately $20,000 per unit exclusive of development costs.

3.1 ALTERNATIVE ONE--A CARTRIDGE SYSTEM



3.1.1 Description

The basic components of a microfiche cartridge storage and retrieval system would be a set of cartridges, a manual storage rack for the cartridges, and one or more readers designed to accept cartridges and automatically select and display individual fiche from within the cartridge. Each cartridge would

hold up to one hundred microfiche. Microfiche within each cartridge would be notch or pin-hole coded from 00 to 99 to facilitate mechanized selection.

The manual storage rack would be of circular, "lazy-suzan" type construction approximately 24 inches in diameter and 30 inches high. The rack would consist of four individual circular trays or carrousels stacked vertically. Each circular tray would hold twenty five cartridges and be capable of rotation independent of any other circular tray. Cartridge locations in the rack would be labeled 1 thru 100. Up to four work stations could be clustered around the circular rack. All tray levels would be within comfortable arm's reach of a user in sitting position. The reader would feature an input port for accepting loaded cartridges. A keyboard would control selection and display of individual fiche.

3.1.2 Capacity

10,000 individual fiche.

3.1.3 Retrieval

Single fiche; maximum 15 seconds, average 8 seconds from acquisition of reference number to visual display.

3.1.4 Index

External. Must include cross reference to microfiche reference number.

3.1.5 Viewer

Off-line. Manual cartridge load. Automatic fiche selection.

3.1.6 Duplication

Off-line.

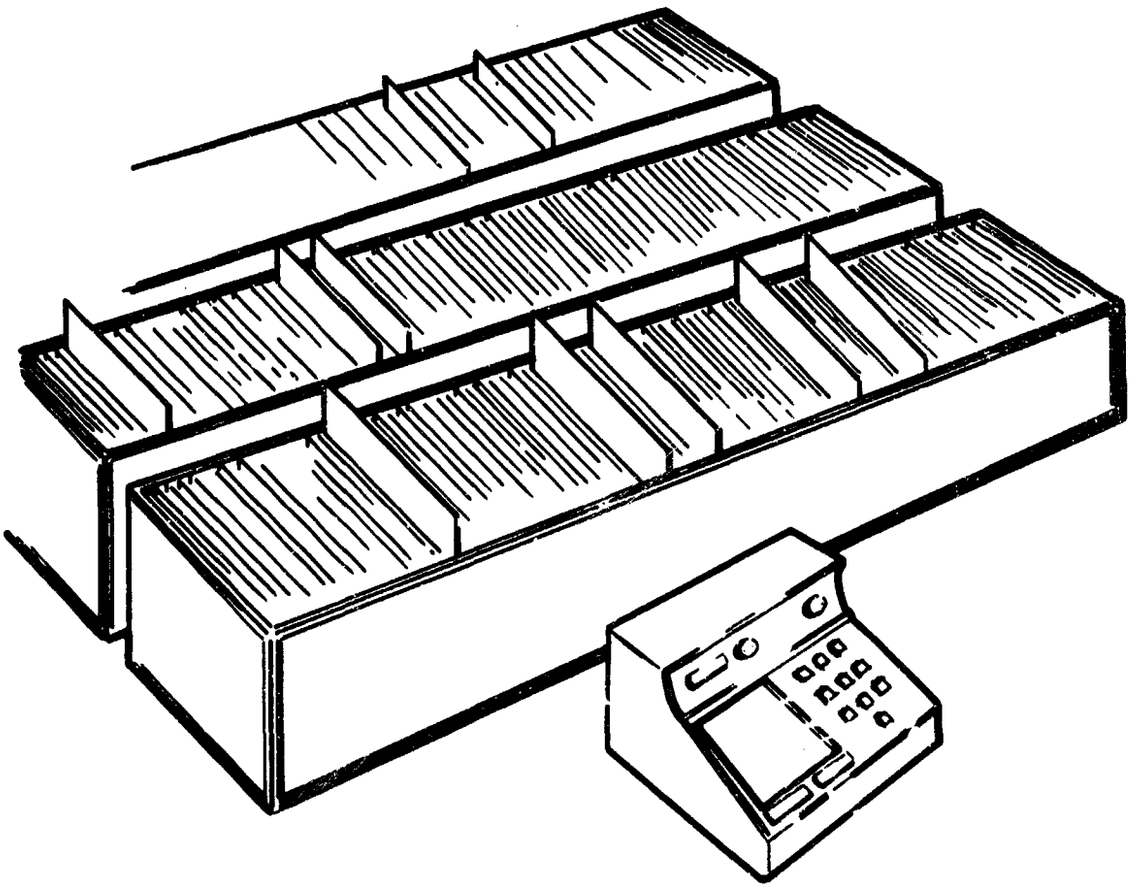
3.1.7 Reproduction

Off-line.

3.1.8 Expandability

System could start as a single carrousel storage rack and grow in collection size increments of 2,500. Off-line equipment in addition to the initial unit could be added as required.

3.2 ALTERNATIVE TWO--SEMI-AUTOMATIC RANDOM-ACCESS SYSTEM



3.2.1 Description

The basic components of a semi-automated random-access storage and retrieval system would be a set of automated trays, each capable of mechanically selecting and manipulating one or more microfiche by matching coded data entered on a keyboard to coded data physically contained on the individual

fiche. In effect, the system would cause a desired fiche to partially move out of the file so that it could be easily distinquished by the human eye from the rest of the microfiche in the collection. Retrieval and handling from this point on would be manual. Fiche would be coded by edge-notch process or equivalent. The code would contain a minimum of fifty six binary positions to permit recording of a reference number and an adequate amount of descriptive data. The system would permit selection of individual fiche on the basis of reference number or groups of fiche simultaneously on the basis of descriptive data. Each automated tray would be capable of holding a minimum of sixty linear inches of microfiche with a nominal packing density of sixty microfiche per inch. The system would permit on-line operation of more than one tray simultaneously.

3.2.2 Capacity.

21,600 fiche for a six-tray system.

3.2.3 Retrieval.

Single or batch. Approximately one second from key board insertion to selection (pop-up) of fiche.

3.2.4 Index.

Internal. Number of elements would be limited; a supplementary external index and/or thesaurus may be required.

3.2.5 Viewer.

Off-line.

3.2.6 Duplication.

Off-line.

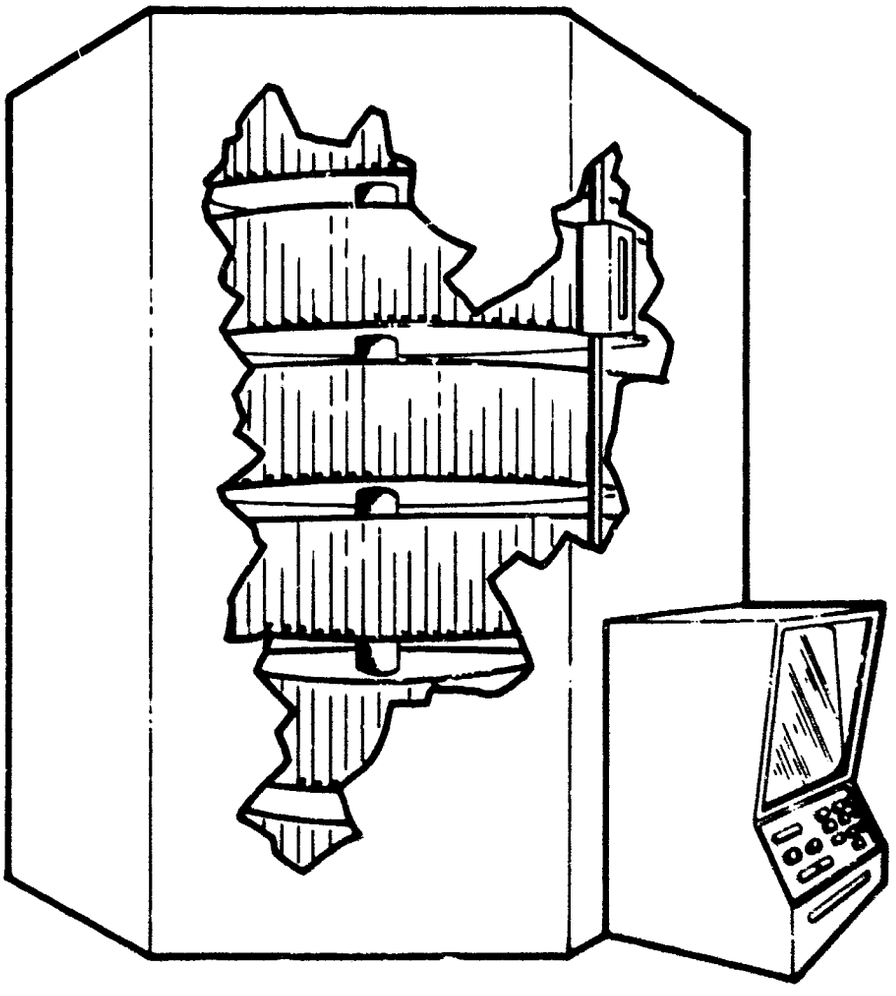
3.2.7 Reproduction.

Off-line.

3.2.8 Expandability.

System could start as a one-tray system (capacity 3600). Additional trays can be added as the collection grows.

3.3 ALTERNATIVE THREE--FULLY AUTOMATED MULTIPLE OUTPUT SYSTEM



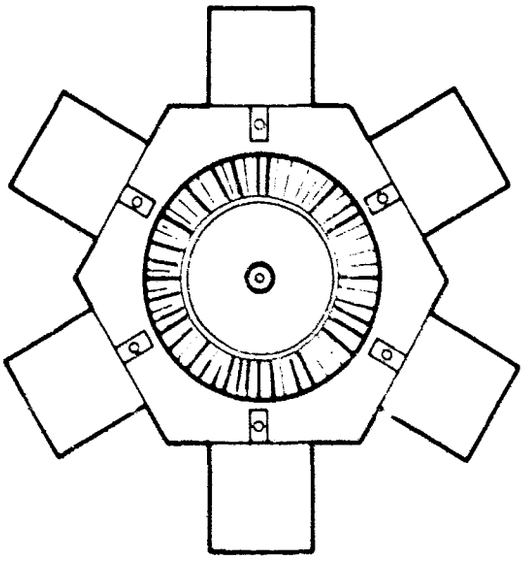
3.3.1 Description

The basic components of this alternative system are a stack of automated circular trays or carrousels, an on-line reader-printer (or other output devices, as will be discussed), and a mechanized selector/retriever device which moves between the carrousels and the reader-printer. The carrousels

and selector/retriever device are housed in a hexagonally shaped cabinet. The reader-printer is mounted on one of the six sides of the hexagonal cabinet. Stored fiche are mounted in thin, notch coded frames. When operating, the selector/retriever device moves vertically on a pole or rail to a designated carrousel, selects a designated fiche as the carrousel rotates, withdraws the fiche from the carrousel, descends, and ejects the fiche from the central cabinet into the reader-printer.

In the above description, only one output device was discussed. The system would, in fact, be capable of accommodating up to six on-line output devices of varied types. Each would be mounted on one of the six sides of the hexagonal cabinet. Each would control its own selector/retriever device inside the cabinet.

Available on-line output devices, in addition to one or more reader-printers, could include a fiche-to-fiche duplicator, a volume printer and/or one or more video units for remote CRT viewing. Each unit would contain a key board for entering retrieval commands. User organizations would select a configuration to fit their own requirements.



The notch-code on the microfiche mounts would accommodate eight decimal digits (one digit position for carrousel designator, five for document reference number, and two for trailer fiche designator). In addition, one binary notch would be used to indicate fiche security classification. This notch could activate disabling mechanisms on the duplicators and printers.

Carrousels would be approximately twenty-four inches in diameter and would accommodate up to 3,000 each. A table top system could accommodate up to six carrousels. A floor model system could accommodate up to ten carrousels.

3.3.2 Capacity

18,000 microfiche with a six-carrousel system, in increments of 3,000.

3.3.3 Retrieval

Single fiche, average time 8 seconds, maximum time 15 seconds, from key board request to output device.

3.3.4 Index

External. Must include cross reference to microfiche reference number including carrousel designator.

3.3.5 Viewer

On-line. Optional. Viewer would have motorized frame advance and reverse capability.

3.3.6 Duplication

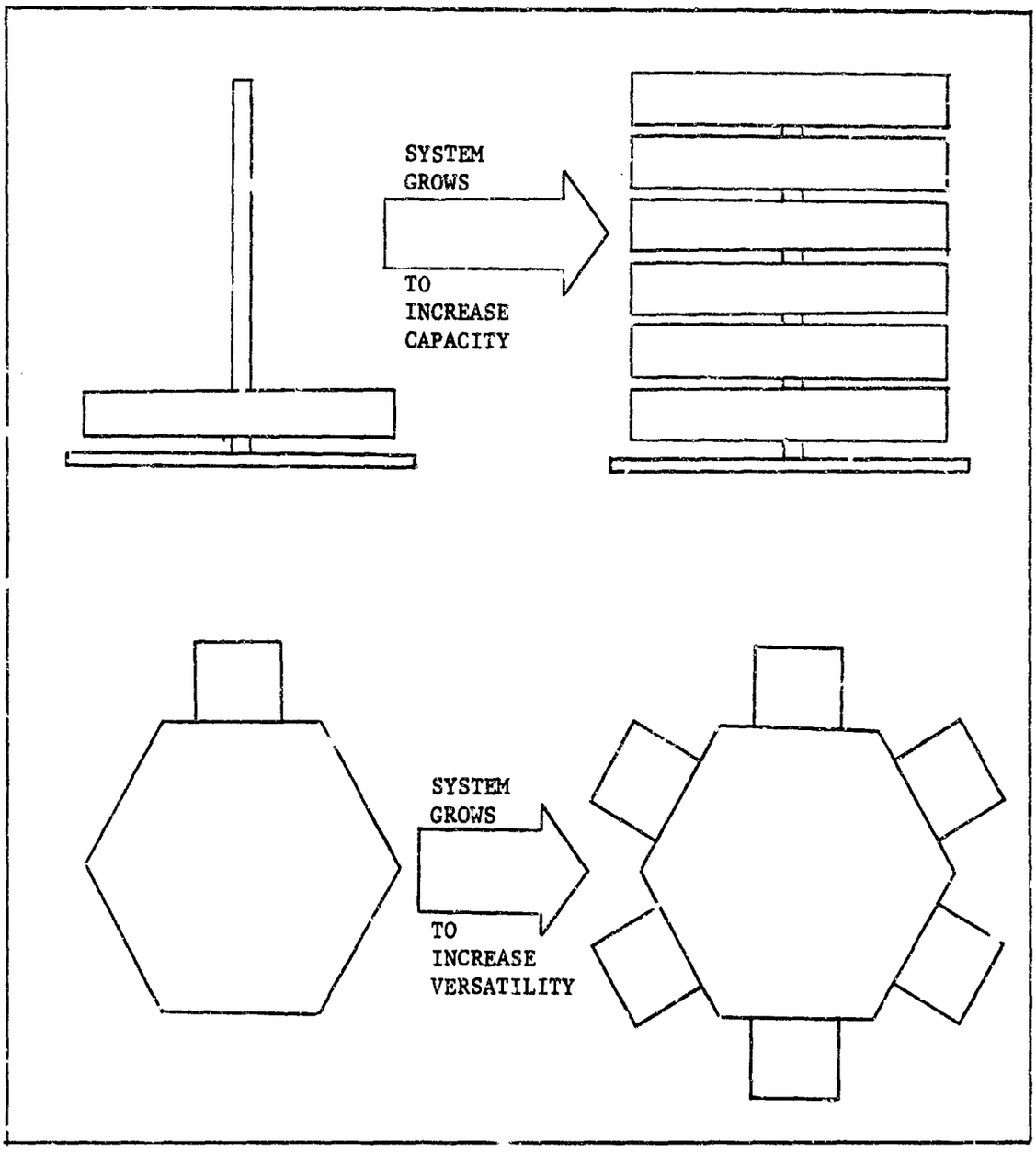
On-line. Optional.

3.3.7 Reproduction

On-line. Optional.

3.3.8 Expandability

Two types of modular expansion would be possible. Carrousels can be added as the collection grows from under 3,000 to 18,000 (30,000 with floor model). Also increased system versatility can be added by installing output devices as requirements and funds dictate, starting with a basic single-output system.



Automatic, Multiple Output System

Modular Expandability--Two Ways

4.0 DESIGN RECOMMENDATION

Two of the three postulated design concepts have been selected for recommendation. The two concepts selected are Alternative One--A Cartridge System and Alternative Three--An Automatic Multiple-Output System.

The cartridge system is recommended for some bench-level and small library type user groups. The automatic, multiple-output system is recommended for some medium-sized library and information center type organizations. Rationale for the selection is discussed below.

4.1 COMPARISON OF ALTERNATIVES

Each alternative design offers certain unique advantages in one or more functional areas.

4.1.1 Search

Alternative Two, the random-access system, provides for a degree of internal indexing. However, because of the limited coding capability presently within the state-of-the-art, most users would continue to rely, at least in part, on some type of external index. It is felt, therefore, that the internal index feature while perhaps adequate for other types of operations, is presently not adequate (in terms of coding versatility) for the library type of operation. Thus, while Alternative Two does provide some indexing capability while the others provide none, the difference is not deemed significant.

4.1.2 Storage

Alternative One, the cartridge system, and Alternative Three, the automated multi-output system, provide capacities of 10,000 and 18,000* fiche, respectively. Technically, Alternative Two has no limit to capacity

*30,000 for ten carrousel version.

(although it should be noted that as capacity increases there is a linear increase in costs and a linear decrease in index selectivity). Each system can grow in increments from a base capacity of approximately three to four thousand fiche.

4.1.3 Retrieval

Each system is capable of retrieving fiche singly. Alternative Two also permits retrieval of multiple fiche simultaneously.

Only Alternative Three is fully automatic. In Alternatives One and Two, some part of the retrieval process is manual. Retrieval time for Alternative Three averages eight seconds. For Alternative One, retrieval time is approximately one second (once cartridge is loaded in viewer) plus the time required to manually select the proper cartridge on the carrousel and load it into the viewer. For Alternative Two, retrieval time is approximately one second plus the time required to manually remove the "popped-up" fiche from the automated tray and position it in the viewer's film carrier.

It is estimated that Alternative Three would be faster overall than either of the other systems; however, each is deemed fully satisfactory for normal library type requirements.

4.1.4 Viewing

The viewing function emerges as the most distinquishing feature of the three alternative systems. The viewing function in Alternative Three is fully on-line and is extremely convenient. In Alternative One, viewing is "on-line" once the cartridge is loaded, and, as such, features speed and handling ease comparable to Alternative Three. In Alternative Two, viewing is completely off-line and offers no more viewing speed or handling convenience than a manual storage system.

Simultaneous viewing of microfiche in the central file is possible in each system (i.e., none of the systems permits the viewing function to preclude access to the central file by other users).

Only Alternative Three, as described, provides the option of on-line viewing from remote locations.

4.1.5 Reproduction

In Alternatives One and Three, the reproduction of single images is accomplished by the printing subsystem of the reader-printer associated with each system. Once each reader-printer is loaded and an image selected, the reproduction of the image is equally convenient in each system. In Alternative Two, no reproduction function is specified.

4.1.6 Duplication

Alternative Three can provide fast, on-line duplication. No duplication capability is specified for the other systems.

4.1.7 File Integrity and Security

Alternative One prevents damage to fiche from human handling and minimizes the problems of misfiling. Alternative Two eliminates the problems of misfiling, but is vulnerable to fiche damage and loss outside the file. Alternative Three provides maximum file integrity. No fiche leave the system. Duplicates are provided to users, if needed.

None of the systems is adequate for storage of classified materials without the employment of external administrative safeguards.

4.2 RECOMMENDATION

4.2.1 Cartridge System

Alternative One, the Cartridge System, is recommended primarily for bench-level type users with active, growing collections which are expected to exceed three or four thousand in the 1970-75 period. (The system might also be attractive to some small libraries, specifically those not able to justify the automated, multiple output system.)

The cartridge system provides the bench-level user with a compact, organized storage device which eliminates manual handling of individual fiche and provides an adequate degree of file integrity. In a bench level group, individual users are usually located in the same physical area, thus there is generally no requirement for remote viewing or satellite files. A single, conveniently located file suffices. Also, bench-level groups tend to be relatively small in number; a limited number of viewing devices (perhaps just one) often satisfies the reading requirements of the group. The cartridge system provides considerable flexibility in file organization which can be put to use best in the bench-level type group. The entire file can be organized in serial order, or portions of the file can be organized with some cartridges designated for special purposes either on a temporary or permanent basis. For example, a special collection of up to 100 documents can be assembled in a single cartridge for a specific project. Individuals working on that project will have immediate, on-line access to all project documents by merely loading the appropriate cartridge in the machine. Similarly, some cartridges can be used to house the personal collections of individual members of the group.

The basic storage device (cartridges and rack) should be available for under $400.00. The cartridge loading reader-printer should cost less than $4,000.00.

The cartridge system is the best of the three alternative systems with respect to the requirements of the bench-level type user.

4.2.2 Automated Multiple-Output System

Alternative Three is recommended for medium size library and information center category users who anticipate an active file size in excess of eight to ten thousand in the 1970-75 period and who serve a large number of regular microfiche users.

This automated system provides modularly expandable storage for up to 30,000 microfiche with a variety of optional on-line output devices. The system is flexible and can be configured several ways to fit the requirements of the using organization. With simultaneous local and/or remote access by up to six users and with four different types of output devices, the system meets the many and varied requirements of active libraries and information centers.

Specific library requirements met by the recommended system are as follows. On-line output devices, offer significant time-savings to individual users. Elimination of manual loading, frame positioning and refiling greatly simplify the individual user's reading activity and increase his efficiency. The optional on-line duplicator supports typical library requirements for supplying microfiche to individual users without disturbing the integrity of the master file. In addition, the duplicator provides an inexpensive method for document distribution (free) which eliminates considerable labor and expense consumed in document circulation (loan) operations. The optional volume printer provides quick, easy service to users requiring whole documents in hard copy. The optional remote CRT device permits access to the central file by an unlimited number of users in laboratories, offices and other locations physically distant from the library.

All of the output devices are self-serve units. Individual users may view, print and duplicate materials in the central file without assistance from library or information center personnel. The savings in man-power should be significant over a period of time.

The majority of medium sized libraries and information centers could place a one-carrousel, one-output device system into immediate use. As the Library's microfiche collection grows, additional carrousels can be inst 'led. As requirements for expanded capabilities develop, additional output devices can be added. The initial one-carrousel, one output device configuration provides the growing library a basic system at a relatively low price, probably under $20,000.00. permitting distribution of the total system costs over a period of years.

5.0 EQUIPMENT SPECIFICATION FOR A CARTRIDGE STORAGE AND RETRIEVAL SYSTEM

5.1 SCOPE

This specification covers requirements for a microfiche storage and retrieval system utilizing cartridge-type storage containers, a rotary storage rack for housing the cartridges, and a cartridge loading reader-printer.

5.2 REQUIREMENTS

5.2.1 General Requirements

The microfiche cartridge storage and retrieval system shall be designed to permit storage, retrieval, viewing and printing of standard 4" x 6" microfiche materials. Cartridges shall be durable, compact containers capable of accommodating up to one hundred individual microfiche. The cartridge rack shall be a sturdy, table-top device consisting of several circular trays, stacked vertically, and each capable of independent rotation around a common

spindle. The reader-printer shall be a separate table-top unit designed to accept the above cartridges and automatically select and display individual fiche as specified via keyboard entry by the operator. The printer subsystem of the reader-printer shall be capable of rapid reproduction of selected images to provide quality prints suitable for immediate use.

5.2.2 Mode of Operation

The system shall allow an operator in a seated position to manually rotate any tray on the storage rack, manually select and remove any cartridge from the rack, manually insert the cartridge into the reader printer and automatically select, view and/or reprint images from any fiche in the inserted cartridge.

5.2.3 Size

a. Cartridge. The dimensions of the cartridge shall be minimum commensurate with good design and shall not exceed 5" x 7" x 3".

b. Rotary Rack. The dimensions of the rotary rack shall be minimum commensurate with good design and shall not exceed 30" in overall height and 30" in diameter.

c. Reader-Printer. The dimensions of the reader-printer shall be minimum commensurate with good design and shall not exceed 24" H x 24" W x 30" L.

5.2.4 Capacity

a. Cartridge. The cartridge shall be designed to hold 100 microfiche including any additional materials, if any, which may be required by the coding scheme.

b. Rotary Rack. The rotary rack shall be designed to hold 100 loaded cartridges.

5.2.5 Material

All components of the system shall be constructed of materials of good commercial quality entirely suitable for the purposes intended. Material shall be free from all defects and imperfections that might affect the performance or serviceability of the finished product.

5.2.6 Strength

All components shall be designed so as to possess adequate structural rigidity to preclude any structural distortion or misalignment sufficient to impair normal operation or photographic resolution as a result of reasonable levels of shock or vibration.

5.2.7 Weight

a. Rotary Rack, loaded. The weight of the rotary rack loaded with one hundred empty cartridges shall not exceed 100 pounds.

b. Reader-printer. The weight of the reader-printer shall not exceed 80 pounds.

5.2.8 Electrical Requirement

The reader-printer shall operate satisfactorily from a 105-125 volt, 60 cycle, single phase AC power supply. The total current drawn shall not exceed 20 amperes at 115 volts.

5.2.9 Noise

Noise generated by components of the system, especially fans or blowers and motor driven transport mechanisms, shall be as quiet as possible and shall not be of an intensity or frequency disturbing to the normal office or library environment.

5.2.10 Temperature

The equipment shall be capable of satisfactory operation in any ambient temperature ranging from 50°F to 100°F and in relative humidity conditions up to 75%. Heat generated by the reader-printer shall not be excessive and heat felt by the reader-printer operator shall be negligible.

5.2.11 Principle Components of the Reader-Printer

The principle components of the reader-printer shall primarily consist of the following: (a) optical system, (b) fiche selector-transport subassembly, (c) frame selector subassembly, (d) screen, (e) printer subassembly, (f) controls and indicators, and (g) cabinet.

a. Optical system. An integrated optical system shall be employed in the reader-printer which will use a common light source and lens system for both the reading and printing functions. Design of the equipment shall permit easy cleaning of all optical system components.

The optical system will include either a zoom or turret-type lens assembly to provide full screen enlargements of microimages reduced 20:1 and 24:1. A prism system will also be included to provide 360-degree rotation of the projected image.

b. Fiche selector-transport. The fiche selector-transport subassembly shall be capable of selecting and withdrawing from a loaded cartridge any specified fiche according to a code physically contained on the fiche. The coding technique may utilize file position, notches, pin-holes or any suitable method for providing discrete identification for individual fiche numbered from 00 to 99. (If the coding scheme selected involves notching, punching or otherwise physically coding the microfiche, an appropriate coding device will be considered a requirement of this specification.) The subassembly will transport selected fiche to the viewing/printing position in an automatic step sequence following selection. At no time during selection or transport shall the emulsion side of the image area make frictional contact with any other surface. A locking

mechanism will be activated by the selector mechanism to prevent manual removal of the cartridge from the reader-printer when any fiche has been withdrawn from the cartridge.

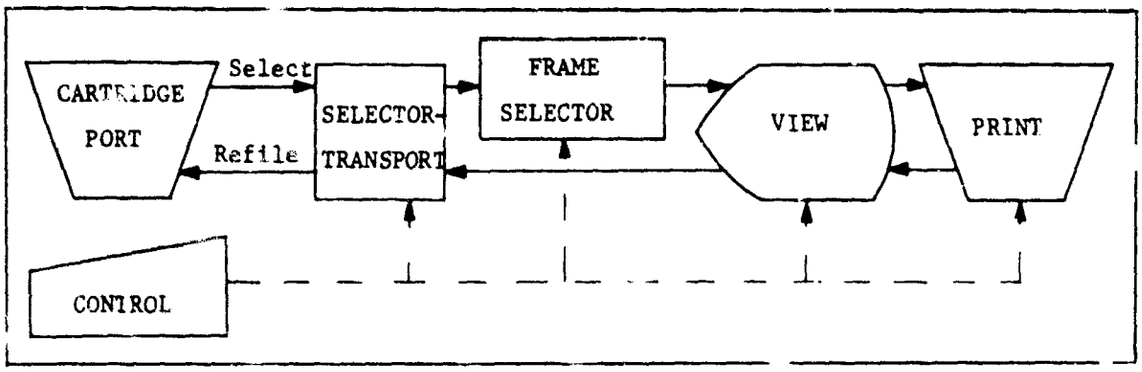
c. Frame selector subassembly. The frame selector subassembly will provide motorized vertical and horizontally movement of the fiche in the viewing position. The subassembly shall be capable of both slow speed and fast speed movement.

d. Screen. Screen size will be 11" x 11" as a minimum. Rear projection will be used to display the microimage on the screen. The screen will be of such a quality as to not impair the resolution of the enlarged image and provide minimum glare and external reflection. The screen angle shall be such that, when the reader is placed on a standard 30" high table, a line perpendicular to the plane of the screen shall be as parallel as possible to the line of sight of a seated operator observing the center of the screen from a normal viewing distance. The distance between the top edge of the screen and the base of the reader-printer shall not exceed 18".

e. Printer subassembly. The printer shall produce quality hard copy of selected images in twelve seconds or less per image. Printing method shall be a dry process. The size of the reproduced image shall be within 75% and 120% of the size of the original document. The time required for the equipment to warm up prior to operation will be kept to a minimum and will not exceed ten seconds under normal conditions and twenty seconds under extreme service conditions.

f. Controls and Indicators. All controls will be mounted in plain view and within comfortable reach of a seated operator. No controls will be located higher than shoulder level of a seated operator. Included shall be controls for turning power on and off, fiche selection, fiche return, horizontal movement, vertical movement, focus, image magnification, and print function. All indicators shall be in plain view and shall include indication of power on, selected fiche number, and selected frame position.

g. Cabinet. The cabinet will house the optical system and all operating mechanisms. The cabinet may be used as the principle support member.



Cartridge System--Reader-printer

6.0 EQUIPMENT SPECIFICATION FOR AN AUTOMATED, MULTIPLE-OUTPUT STORAGE AND RETRIEVAL SYSTEM

6.1 SCOPE

This specification covers requirements for an automated microfiche storage and retrieval system of modular construction which consists of up to six circular trays and from one to six selector-retrieval mechanisms all housed in a central, hexagon-shaped cabinet. This central automated file is capable of on-line interface with up to six output devices of various types. This specification will include requirements for one of the output devices, an on-line reader-printer. Other types of output devices shall be described in this specification only to the extent required to provide clarity to the specification for the central automated file.

6.2 REQUIREMENTS

6.2.1 General Requirements

The automated microfiche storage and retrieval system shall be designed to provide on-line storage, retrieval, local and remote viewing, printing and duplication of standard 4" x 6" microfiche materials. Stored files will be housed in circular trays or carrousels which are stacked inside a six-sided cabinet. Each side of the central cabinet will provide a potential location for one of a variety of types of output devices. Each output device will be linked to a selector-retriever mechanism inside the cabinet which will retrieve designated microfiche and eject it through an output slot in the cabinet into the output device. Output devices available may include a reader-printer, fiche-to-fiche duplicator, volume printer, and a remote CRT viewing subsystem.

6.2.2 Mode of Operation

The system shall allow an operator to retrieve any microfiche in the central file by entering a microfiche reference number on the keyboard of an output device. The system shall automatically transport the designated fiche to this output device. If this output device is a reader-printer, the operator may view all or portions of the fiche contents, print selected images and return the fiche automatically to storage. If the output device is a fiche-to-fiche duplicator, a duplicate fiche will be produced and the original returned automatically to storage without any further action on the part of the operator. If the output device is a volume printer the operator will enter data via keyboard regarding start-frame, stop-frame, number of trailer fiche and number of copies desired. The fiche will be automatically returned to storage upon completion of the printing sequence. If the output device is a remote CRT viewing subsystem, a video image of the microfiche will be transmitted to a remote display unit which will have external features and controls similar to the reader-printer Frame movement and image focus mechanisms in the transmitting unit will be controllable at the remote display unit.

6.2.3 Capacity

Total system capacity shall be 18,000 microfiche. [This figure is based on the table-top, six-carrousel design for which this system specification is applicable. An alternative design is a stand-alone, ten-carrousel system which would provide a total system capacity of 30,000 microfiche. Except for capacity and related parameters, this specification is also applicable to the ten-carrousel design.]

6.2.4 Size

a. Central Cabinet. The overall dimensions of the central cabinet shall be minimum commensurate with good design and aesthetic considerations and shall not exceed 40" in overall height or 40" between opposite corners of the hexagon. In order that the unit shall be capable of passing through standard industrial door spaces, the distance between opposite surfaces of the hexagon, including molding and trim, shall not exceed 35".

b. Reader-Printer. The dimensions of the reader-printer shall be in proportion to the dimensions of the central cabinet. The width of the reader-printer shall be several inches less than the width of one side of the central cabinet. The height of the reader printer shall not exceed 24".

6.2.5 Material

All components of the system shall be constructed of materials of good commercial quality entirely suitable for the purposes intended. Material shall be free from all defects and imperfections that might affect the performance or serviceability of the finished product.

6.2.6 Strength

All components shall be designed so as to possess adequate structural rigidity to preclude any structural distortion or misalignment sufficient to impair normal operation or photographic resolution as a result of reasonable levels of shock or vibration.

6.2.7 Weight

a. Central Automated File. The weight of the central cabinet loaded with six empty carrousels and six selector-retriever mechanisms shall not exceed 500 pounds.

b. Reader-printer. The weight of the reader printer shall not exceed 80 pounds.

6.2.8 Electrical Requirement

The system shall operate satisfactorily from a 105 to 125 volt, 60 cycle, single phase AC power supply.

6.2.9 Noise

Noise generated by components of the system shall be minimal and shall not be of an intensity or frequency disturbing to the normal office or library environment.

6.2.10 Temperature

The equipment shall be capable of satisfactory operation in any ambient temperature ranging from 50°F to 100°F and in up to 75% relative humidity. Heat generated by the equipment shall not be excessive and heat felt by the operator of any output device shall be negligible.

6.2.11 Principle Components of the Central Automated File

The principle components of the central automated file shall consist of the following: (a) carrousels, (b) carrousel support and drive subassembly, (c) fiche selector-retriever subassembly, (d) control subassembly, and (e) cabinet.

a. Carrousels. Each carrousel shall be designed to hold up to 3,000 individual microfiche. Packing density of microfiche in carrousels will not

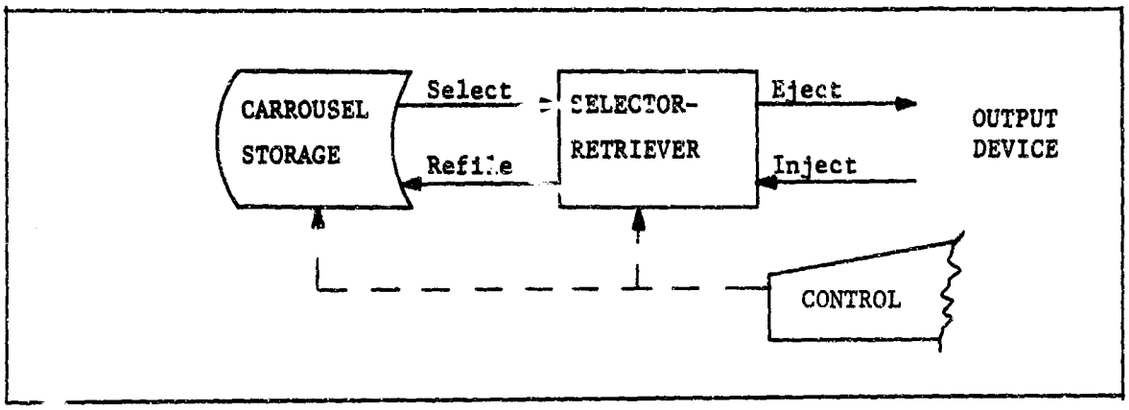
exceed 40 fiche per linear inch along the outside circumference of the carrousel. Minimum circumference shall be 75".

b. Carrousel support and drive subassembly. Carrousels shall be supported by a common spindle. Design shall permit easy addition or removal of carrousels from the system. Carrousels shall be motor driven. Rotation of each carrousel will be independent of the movement of other carrousels.

c. Fiche selector-retriever subassembly. The central cabinet shall contain one selector-retriever subassembly for each output device. Each selector-retriever shall move vertically on a fixed pole or rail. The subassembly shall be capable of moving adjacent to a designated carrousel, selecting a designated fiche as the carrousel rotates, withdrawing the fiche, descending and ejecting the fiche through an output slot in the central cabinet into the receiving mechanism of an on-line output device. The subassembly will select the designated fiche according to a notch code physically contained on the fiche or on a metal strip attached to the fiche. (If the code is physically contained on the fiche, an appropriate coding device shall be considered a requirement of this specification.) The code will consist of twelve notches to provide sufficient variations to distinguish between the individual fiche in a single carrousel.

d. Control Subassembly. A control subassembly will interface with the keyboard of each output device to control the motion of the carrousels and selector-retrievers.

e. Cabinet. The cabinet will house the carrousels and all central file mechanisms. The sides and top will be readily removable as a unit for servicing. Only the base may be used as a principle support member. It shall be constructed so as to permit easy addition or removal of carrousels from the central file.



Automated Multiple Output System--Central File Subsystem

6.2.12 Principle Components of the Reader-Printer

The principle components of the reader-printer shall consist of the following: (a) optical system, (b) fiche receiver-transport subassembly, (c) frame selector subassembly, (d) viewing screen, (e) printer subassembly, (f) controls and indicators, and (g) cabinet.

a. Optical system. An integrated optical system shall be employed in the reader-printer, which will use a common light source and lens system for both the reading and printing functions. Design of the equipment shall permit easy cleaning of all optical system components. A prism system shall be included to provide 360-degree rotation of the projected image.

b. Fiche receiver-transport subassembly. This subassembly shall be capable of accepting fiche injected into the reader-printer and transporting it to the viewing/printing position in an automatic step sequence. Upon completion of use, this subassembly will return the fiche to central cabinet. At no time during the handling of the fiche shall the emulsion side of the image area make frictional contact with any other surface.

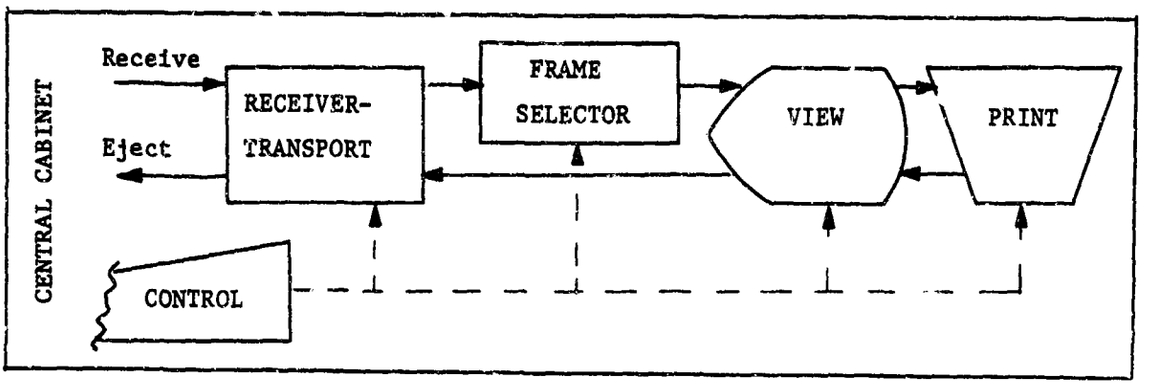
c. Frame selector subassembly. The frame selector subassembly will provide motorized vertical and horizontal movement of the fiche in the viewing position. The subassembly shall be capable of both slow speed and fast speed movement.

d. Screen. Screen size will be 11" x 11" as a minimum. Rear projection will be used to display the microimage on the screen. The screen will be of such a quality as to not impair the resolution of the enlarged image and provide minimum glare and external reflection. The screen angle shall be such that, when the reader is placed on a standard 30" high table, a line perpendicular to the plane of the screen shall be as parallel as possible to the line of sight of a seated operator observing the center of the screen from a normal viewing distance. The distance between the top edge of the screen and the base of the reader-printer shall not exceed 18".

e. Printer subassembly. The printer shall produce quality hard copy of selected images in twelve seconds or less per image. Printing method shall be a dry process. The size of the reproduced image shall be within 75% and 120% of the size of the original document. The time required for the equipment to warm up prior to operation will be kept to a minimum and will not exceed ten seconds under normal conditions and twenty seconds under extreme service conditions.

f. Controls and Indicators. The reader-printer shall have external controls for power on and off, entry of microfiche reference number (reference number shall be obtained from external index and shall contain carrousel designator as its first digit), microfiche refile, frame selection, focus, image magnification and print function. All controls will be mounted in plain view and within comfortable reach of a seated operator. No controls will be located higher than shoulder level of a seated operator. All indicators shall be in plain view and shall include indication of power on, microfiche reference number, carrousel-in-use, failure-to-find, and frame position or number.

g. Cabinet. The cabinet will house the optical system and all operating mechanisms. The cabinet may be used as the principle support member.



Automatic Multiple Output System--Reader-printer Subsystem

APPENDIX A

This appendix contains a list of the fifty (50) DoD facilities visited by members of the SDC study team during the data collection phase of this study.

DDC SMALL USER SURVEY SAMPLE*

User Code	Organization
00067	Commanding Officer Naval Air Station-Patuxent ATTN: Code ADSC-PUB and PRTG Bg 112 Patuxent River, Maryland, 20670
00071	Naval Postgraduate School ATTN: Prof. George R. Puckett, Lib. Monterey, California 93940
00073	Commander Naval Oceanographic Office ATTN: Code 1640-Lib Washington, D. C. 20390
00134	Commander OAR-Holloman (Det 8 ORA-RRRD) Holloman AFB, New Mexico 88330
00340	Commander Naval Ordnance Lab-White Oak ATTN: Code 730-Lib-Eva Liberman Room 1-315 Silver Spring, Maryland 20910
00407	Commander Naval Weapon Lab ATTN: Tech Lib Hd-Cathryn Lyon Dahlgren, Virginia 22448
00791	Chief Naval Research Branch Office ATTN: Tech Info Off - L. Rains 495 Summer Street Boston, Massachusetts 02110

*The list contains some users who are not considered small users. They were included in the survey for purposes of collecting comparative data.

User Code	Organization
01438	Commander AFSC (SCPSL-Library) Andrews Air Force Base Washington, D. C. 20331
01801	Commanding Officer and Director Army Cold Rgns Rsch - Eng Lab ATTN: Lib P. O. Box 282 Hanover, New Hampshire 03755
02045	Commanding Officer Naval Wpn Ctr - Corona Labs ATTN: Library Corona, California 91720
02151	Commanding Officer Naval Pers. Rsch. and Dev. Lab. ATTN: Lib-Miss Gallagher Washington Navy Yard (Bg 200, Rm 3308) Washington, D. C. 20390
02202	Commanding Officer Naval Ordnance Station-Indian Head ATTN: Tech Lib-Mr. Phillip Rochlin Indian Head, Maryland 20640
02264	Commander Naval Shipyard-San Francisco Bay Shipyard Tech Lib ATTN: Mrs. June McCormick Admin. Support Design Div. Bg 746 Vallejo, California 94592
02317	Director Naval Rsch Lab Orlando ATTN: USR Lib P. O. Box 8337 Orlando, Florida 32806

User Code	Organization
03470	Chief Army Air Def Human Rsch Unit Fort Bliss, Texas 79906
04440	Officer in Charge Naval Biol Lab ATTN: CDR Thomas G. Akers Naval Sup Ctr Oakland, California 94625
04792	Commander AFWL (WLIL - Tech Lib) Kirtland AFB, New Mexico 87117
04913	Commander Naval Ship Systems Command Technical Library Division ATTN: Code 2052-Lib Room 1532 Main Navy Washington, D. C. 20360
04971	Commander AEDC (AETS) Arnold AFB, Tennessee 37389
05111	Commanding Officer Fort Detrick ATTN: Tech Lib-Act Ch. Gerald Beveridge Frederick, Maryland 21701
05128	Commander ADTC (ADBPS 12 - AFL 2825) Eglin AFB, Florida 32542
05503	Commander AFFTC (FTBPP 2 Tech Lib) Edwards AFB, California 93523

User Code	Organization
05624	Adjutant General's Office-Staff Spt Dir Army Lib ATTN: ASDIRS-Miss Pauline C. Ramsey The Pentagon, Room 1A534 Washington, D. C.
05871	Asst Chief of Staff-Comm and Elct TAC Sys Dir-Audio-Visual Div ATTN: CETS-6 Washington, D. C. 20315
05978	Commander Weather Wing 5 (Ch Aerosp Sci-Ingram) Langley AFB, Virginia 23365
07217	Commanding Officer Watervliet Arsenal Tech Info Svc Ofc ATTN: SWEWV-RDT Watervliet, New York 12189
07499	Commandant Army Air Defense School Technical Library - Classified ATTN: AKBAAS-SY-F P. O. Box 5040 Fort Bliss, Texas 79916
07987	Commanding Officer Army Rsch and Dev Ctr-Aberdeen ATTN: AMXRD-XSE Aberdeen Proving Ground, Maryland 21005
08303	Commander Hq USAF (AFCSAMI-Donoghue, John X.) The Pentagon, Room 1D384 Washington, D. C. 20330

User Code	Organization
08635	Commander ASD (ASFS) Wright-Patterson AFB, Ohio 45433
09844	Commander ASC (ASNJP-20) Wright-Patterson AFB, Ohio
10220	Commander AFFDL (FDP) Wright-Patterson AFB, Ohio 45433
10574	Commanding Officer Army Material Command Ammunition School ATTN: AMXSV-ASA Savanna Army Depot Savanna, Illinois 61074
11163	Director Natl Oceanographic Data Ctr Archives Br ATTN: Code 2220-Charlotte M. Ashby Washington Navy Yard Bg 160 Washington, D. C. 20390
13301	Director Def Comm Agency Natl Mil Comd Sys Spt Ctr ATTN: Lib-K-ZUZICK The Pentagon, Room BE685 Washington, D. C. 20301
14208	Chief Naval Research ATTN: Code 430 A 18th Street & Constitution Avenue, NW Washington, D. C. 20360

User Code	Organization
14287	Commander AFATL (Stinfo Office) Eglin AFB, Florida 32542
14559	Commanding Officer Naval Ordnance Station Wil Eng Ref Ctr ATTN: Tech Pub 7500 W. Roosevelt Rd. Forest Park, Illinois 60130
14604	Commander ASD (ASNPS-40) Wright-Patterson AFB, Ohio
14710	Commander ASD (ASBO 1) Weight-Patterson AFB, Ohio 45433
15423	Commanding Officer Naval Ammo Depot-St. Juliens Creek ATTN: Code 182-Quality Eval. Lab Portsmouth, Virginia 23702
15465	Deputy Chief Naval Mat. Command, Rm. 1019, Main Navy Bg ATTN: NMAT 0325D - Arthur R. Hinkley Washington, D. C. 20360
15559	Commander Fleet Abn Elct Tng Unit - Pacific ATTN: Code 06B Naval Air Station - North Island San Diego, California 92135

User Code	Organization
16692	Commander AFCRL (CRFC) L G Hanscom Field Bedford, Massachusetts 01730
18329	Commander AFSC (SCLSB) Andrews AFB Washington, D. C. 20331
18486	Asst Chief of Staff-Forces Dev.-Army Org-Unit Tng and Readiness Dir. ATTN: OP RPT BR The Pentagon, Room 3B486 Washington, D. C. 20310
19338	Director Defense Language Inst. TNG Div ATTN: Plans Prog Eval. Naval Sta. Anacostia Annex Washington, D. C. 20390
19363	Commander AFLC Wright-Patterson AFB, Ohio 45433
19495	Commanding Officer Naval Ammo Depot-Crane R and D Dept. ATTN: Lib-C S Maick Crane, Indiana 47522
19636	Commanding General Army WPN Command Science Information Division ATTN: ANSWE-RER-L Rock Island, Illinois 61201

APPENDIX B

This appendix contains a copy of the Survey Questionnaire which was used during the data collect on phase of the study.

DDC MICROFICHE SYSTEM STUDY

SURVEY QUESTIONNAIRE

Purpose of this Questionnaire. This questionnaire is being used in a study sponsored by the Defense Documentation Center (DDC). The study is being conducted by the System Development Corporation. The objective of the study is to develop design specifications for a low-cost microfiche storage and retrieval system for use by small DOD field installations. Design specifications so developed will provide data required for the construction of prototype equipment. The study will provide data of interest to all DDC users. Study participants may anticipate receiving information about the study's results later in the year.

Organization of Questionnaire

SECTION A. GENERAL INFORMATION.

SECTION B. EQUIPMENT. Designed to obtain data on existing equipment owned by the activity being surveyed. Features. Problems. Plans.

SECTION C. COLLECTION DESCRIPTION. Measures size and composition of total collection, duplication in media, growth patterns and growth factors with emphasis on technical reports and microfiche.

SECTION D. OVERALL OPERATION. Defines interactions between the activity being surveyed and its users, suppliers and sponsor. Measures the size, composition and basic requirements of the user population. Determines services to users. Obtains data on suppliers and volumes and types of materials received. Defines internal organization and basic functions of activity.

SECTION E. MICROFICHE SYSTEM DESCRIPTION. Questions in this section focus on the activity's microfiche handling procedures including processing requests, indexing, storage, retrieval, displays, reproduction and control. The first half of the section is designed to obtain descriptive data sufficient to accurately define system elements and procedures. The second half obtains rate, volume and capacity data related to the system's operation.

SECTION F. USER PREFERENCES. This section is designed to obtain data on user attitudes regarding present and future use of microfiche materials and equipment.

POST-INTERVIEW CHECKLIST. This portion of the questionnaire will be used by the SDC project member in completing his interview report.

Interview Schedule

20-30 minutes -- introduction, tour of facility, microfiche equipment and procedures demonstrations, and general data collection.

1-2 hours ------ in-depth interview with facility manager and other staff as appropriate.

1-2 hours ------ interviewer's time for completing data collection report. Only minimal assistance from the facility staff may be needed.

Survey Questions

A. GENERAL INFORMATION

1. Name of library or information center _____

(Note: Throughout this questionnaire, the above will be referred to as the "activity.")

2. Activity's mailing address _____

_____

_____

_____

_____

3. Organizational structure. List all echelons from DOD down to the level of the activity being surveyed.

Department of Defense (DOD) _____

_____

_____

_____

_____

_____

_____

_____

A. GENERAL INFORMATION (continued)

4. Type of activity: Indicate which term best describes the activity's function:

Technical Library _____

Project Central Files _____

Information Center or Special Collection (Describe below) _____

Other (Describe below) _____

5. Facility clearance: _____

6. Personnel assisting in pletion of questionnaire:

NAME	TITLE	PHONE NUMBER

B. EQUIPMENT

1. List all equipment possessed by the activity which is a part of its microfiche handling system (reader-printers, cameras, processors, power files, manual files, automatic storage and retrieval equipment, etc.)

Under "Function(s)," indicate how the activity uses the equipment (e.g., customer self-service, volume reproduction, staff use only, not used, etc.)

Under "Problems or Other Comments" include user opinion regarding what equipment features are useful or not useful, convenient or inconvenient, etc. (How would he have designed it? Does he need it? What features are missing? What features aren't used? Etc.)

Name/Model	Year Acquired	Approx. Cost	Function(s)	Problems or Other Comments

B. EQUIPMENT (continued)

2. In addition to equipment listed above, what other important related equipment is possessed by the activity?

Name/Model	Function (how and/or by whom used)

3. Is equipment on order at this time or do firm plans exist to acquire additional equipment in this fiscal year (FY 1970)?_____ In FY 1971? _____
If yes, please comment.

C. COLLECTION DESCRIPTION

1. What is the approximate number of titles in the activity's total collection? _____

   Indicate the categories of documents which this total includes (e.g., books, technical reports and periodicals).

2. Check media used in the collection.

Hard copy (printed matter)	_____	Magnetic tape	_____
Microfiche	_____	Other _____	_____
Microfilm, 16 mm	_____	_____	_____
Microfilm, 35 mm	_____	_____	_____
Aperture cards	_____	_____	_____
Other microforms (specify)	_____		

3. What types of microfiche does your collection contain?

   COSATI (20:1 reduction ratio with 60 images) _____

   NMA (24:1 reduction ratio with 98 images) _____

   Other _____ _____

   _____ _____

C. COLLECTION DESCRIPTION (continued)

4.

	Total Collection	Technical Reports only
A. Approximate number of titles		
B. Approximate number of titles in hard copy		
Of amount on line B, how many are not duplicated in any other media?		
How many are duplicated on microfiche?		
How many are duplicated on 16mm microfilm?		
How many are duplicated on 35mm microfilm?		
How many are duplicated on other media?		
_____		
_____		
C. Approximate number of titles in microfiche		
Of amount on line C, how many are not duplicated on any other media?		
How many are duplicated on 16mm microfilm?		
How many are duplicated on 35mm microfilm?		
How many are duplicated on other media (excluding hard copy)?		
_____		
_____		
D. How many titles does the collection contain which are <u>not</u> in hard copy or microfiche (e.g., only on microfilm, aperature cards, computer tape, etc), if any. Specify media.		

C. COLLECTION DESCRIPTION (continued)

5. Indicate the approximate number of titles in collection:

	Total Collection:	Technical Reports Only:
five years ago	_____	_____
two years ago	_____	_____

6. Is growth rate in next five years expected to be lower than, higher than or the same as that of the past five years? _____ Why?

C. COLLECTION DESCRIPTION (continued)

7. Year microfiche collection started _____

Approximate size of collection for each year since 1965
(enter 0 where applicable)

1965 __ ____
1966 _____
1967 _____
1968 _____
1969 _____
1970 _____

8. Estimate the size of the microfiche collection in the following years?

1971 _____
1972 _____
1973 _____
1974 _____
1975 _____

9. What factors provide the basis for this estimate?

C. COLLECTION DESCRIPTION (continued)

10. What factors effect the ratio of microfiche-to-hard copy in the collection?

11. Has the utilization of microfiche by the activity resulted in an appreciable change in operating costs? Increase _____. Decrease _____. No appreciable change _____. Explain.

C. COLLECTION DESCRIPTION (continued)

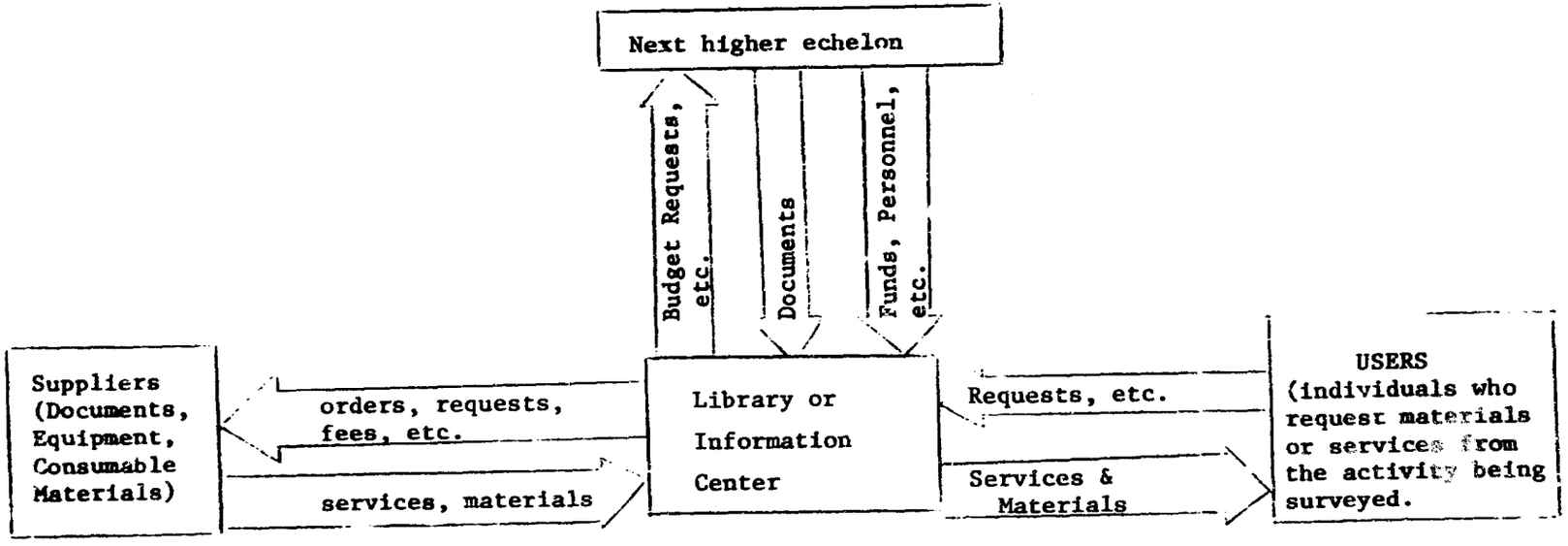
12. Highest security classification of materials in the total collection? _____
Microfiche collection _____ Other microforms collection _____

13. What percentage of the microfiche collection is on negative film? _____

14. What percentage of the microfiche collection is on positive film? _____

15. Which is preferred by users, negative or positive? _____ Why?

D. OVERALL OPERATIONS



The above chart may prove convenient as a reference point with respect to the questions being asked in this section.

D. OVERALL OPERATIONS (continued)

1. Total number of personnel in the activity's user-population _____

   Of this total, what percent are estimated to be regular users (contact the activity at least once every two months) _____

2. To what agency(s) do individual users belong? Approximately what percent is represented by each? (If number of agencies exceeds four, group agencies representing less than 10% under "other.")

Organization	Percent

D. OVERALL OPERATIONS (continued)

3. Where are individual users physically located (exclude activity's staff)?
Estimate percentages:

Within same building	_____%
Nearby buildings (walking distance)	_____%
Greater Distances up to 2 mi	_____%
Over 2 miles	_____%

4. In which of the following areas are individual users primarily engaged?

Basic research	_____
Research, Development, Testing & Evaluation	_____
Procurement	_____
Program and Project Management	_____
Administration	_____
Other _____	_____
_____	_____

5. What percent of the user population are:

Scientists or engineers	_____%
Management personnel	_____%
Technicians	_____%
Administrative or support personnel	_____%
Other _____	_____%
_____	_____%

D. OVERALL OPERATIONS (continued)

6. Indicate types of services which the activity provides its users.

Loan technical reports on hard copy	_____
Loan technical reports on microform (specify)	_____
Loan other (books, periodicals, etc.)	_____
Distribute materials (give away microfiche, etc.)(specify)	_____
Provide announcements (accession lists, abstracts, etc.)	_____
Conduct bibliographic searches	_____
Procure inter-library loans	_____
Do translations	_____
Provide reproduction or media conversion services (specify)	_____
Other (specify)	_____
_____	_____
_____	_____
_____	_____
_____	_____

7. Does the activity charge fees for any service or materials? _____ If yes, specify service or material and fee.

8. Do any users have microfiche equipment at their working area? _____ If yes, discuss.

D. OVERALL OPERATIONS (continued)

9. Indicate the approximate number of documents received from all sources during 1969.

Source	Hard Copy	Microfiche	Other Microform	Other
DDC				
NASA				
CFSTI				
AEC				
HEW				
Commercial Publishers or Distributors				
Industry				
Internal (higher echelon, etc.)				
Others _____				

10. What type of outside services has the activity used in the last 2 years in support of its operations (e.g., microfilming of collection by outside contractor, reproduction support, etc.)?

D. OVERALL OPERATIONS (continued)

11. Briefly discuss the functions of members of the activity's staff (especially as their functions relate to microfiche handling).

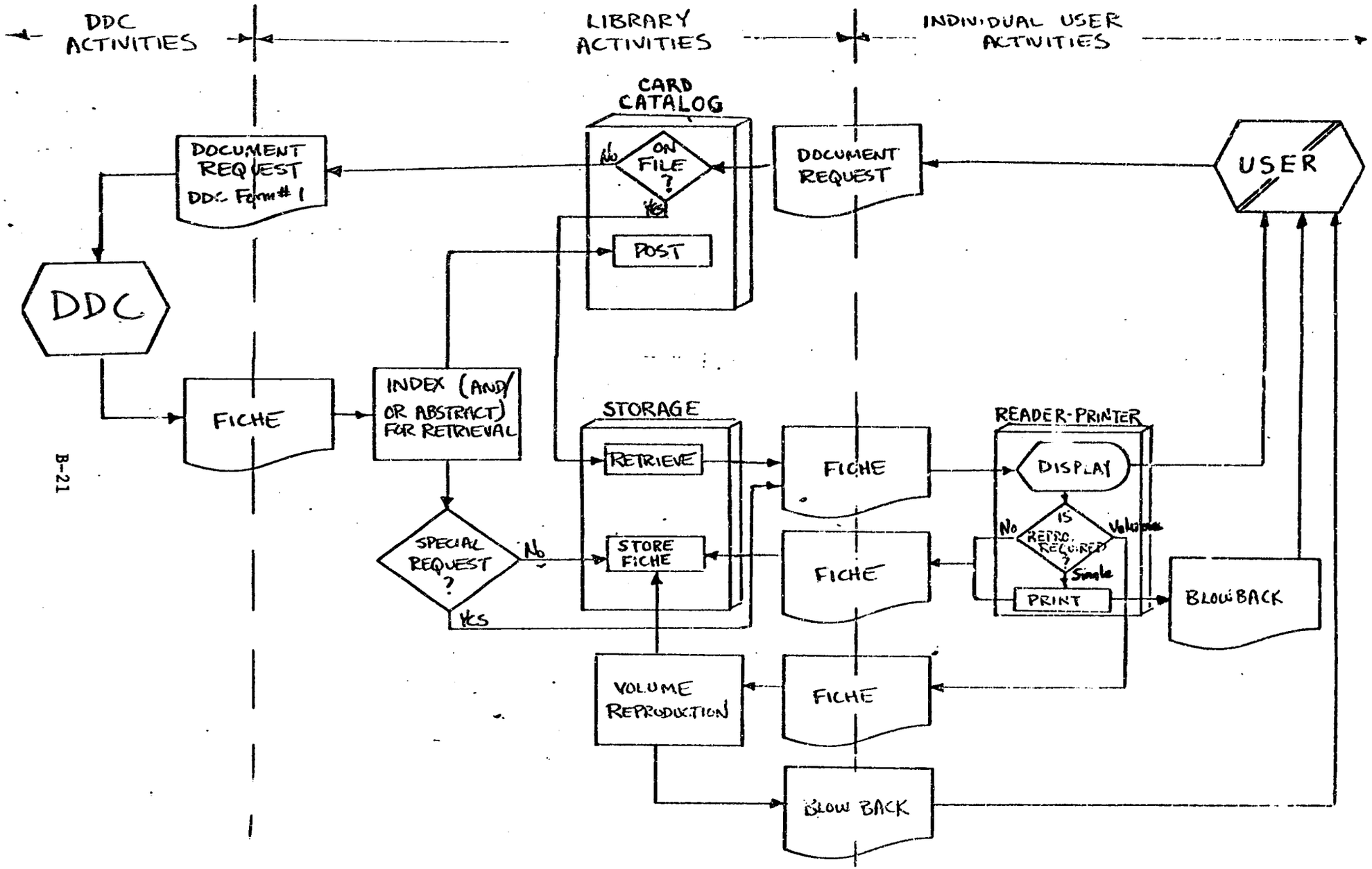
D. OVERALL OPERATIONS (continued)

12. What is allocated in activity's budget for purchase of documents and equipment?

Documents _____ Equipment _____

13. Is microfiche or microfiche equipment specifically itemized in budget? _____ Discuss.

14. What major microfiche-related expenditures are anticipated in the next two years? Five years?



B-21

[Note: The questions in the following section are designed to provide data needed for the development of a system flowchart similar to the above example.]

E. MICROFICHE SYSTEM DESCRIPTION

1. What is the role or purpose of microfiche in this activity? (What is the reason for having microfiche? Is it really needed? Does it save money? Space? Time?

[Note: Questions 2 through 15 below apply only to procedures related to UNCLASSIFIED materials.]

2. Describe user request procedures. Is it verbal, written, other? If written, attach sample request form to this questionnaire.

3. Do s user request procedure (written) permit user to specifically request microfiche versus hard copy? _____ If yes, comment on user practice.

4. Can user access microfiche index and/or storage equipment without assistance from library or information center personnel? _____ If yes, discuss frequency of practice.

E. MICROFICHE SYSTEM DESCRIPTION (continued)

5. Briefly describe staff procedures for processing a request for microfiche (what file(s) must be checked, what records must be maintained, etc.).

6. How does above procedure differ if microfiche is not specified by user. What policies apply, if any, regarding media eventually delivered to user? What is frequency of occurrence?

7. How is UNCLASSIFIED microfiche stored? Describe container, arrangement in storage, etc.

8. Describe UNCLASSIFIED microfiche <u>retrieval</u> process. Is it manual, semi-automatic, automatic? Who does it and how is it done?

E. MICROFICHE SYSTEM DESCRIPTION (continued)

9. How is UNCLASSIFIED microfiche physically delivered to the user (automatic machine output, handed across counter, mailed, courier, pneumatic tube, televised, etc.)? Does user receive the original or a duplicate?

10. How does user display microfiche (automatically displayed when retrieved, manually on activity-owned machine, manually on his machine, etc.)?

11. Is user permitted to check-out microfiche materials on a loan basis? _____
If yes, discuss rules. Time limit.

12. Again, if yes above, what effect does "loaned" status of microfiche have on requests by other users for same material.

E. MICROFICHE SYSTEM DESCRIPTION (continued)

13. What reproduction services are performed at user request? Discuss procedures, capabilities, response times.

14. Do individual users have direct access to reproduction equipment (including single-copy output of reader-printers)? _____ If yes, discuss.

15. Is an externally prepared index ever used to retrieve microfiche from storage? (Example: DDC Technical Abstracts Bulletin Index) _____ If yes, discuss.

Does activity use DDC's Rapid Response Bibliography service? _____ Comment.

16. Does the activity prepare its own microfiche catalog?____ If no, skip to question 25.

17. Indicate the type(s) of index prepared: Author ___, Title ___, Subject ___, Uniterm or Key Word ___, Corporate Author ___, Other (specify) _____.

18. If a subject index is prepared, are COSATI fields and groups used? _____ Is a thesaurus used? _____ If yes, identify.

E. MICROFICHE SYSTEM DESCRIPTION (continued)

19. Indicate the elements of the technical report from which the index terms are derived:

AD Number ____, Document Number ____, Title ____, Introduction ____, Body of Document ____, Abstract ____, Citations ____, Summary ____, DD Form 1473 (Document Control Data-R&D) ____, Other (specify) _____.

20. Is the index data derived from the header data on the microfiche or must the microfiche be viewed in a reader to produce the index?

21. Is hard copy reproduced for either abstracting or indexing purposes? _____

22. Estimate the percentage of microfiche received from suppliers which is not indexed, stored, or otherwise recorded. _____%

23. Is it the activity's policy to circulate new accessions on microfiche prior to indexing or abstracting, after indexing or abstracting is completed, or both depending on circumstances?

_____

Explain.

24. Is index(es) published for internal dissemination? _____ If available, interviewer should obtain copy.

E. MICROFICHE SYSTEM DESCRIPTION (continued)

25. Briefly describe the activity's step-by-step procedure from the time a new microfiche is received from a supplier until it is placed in storage. Estimate time lapse assuming no demand from a user occurs during period.

E. MICROFICHE SYSTEM DESCRIPTION (continued)

26. Are difficulties encountered in updating the microfiche files?
(Specifically; in revising/replacing an entire microfiche, in reclassifying microfiche, or in changing header data.)

27. Do users or staff refile microfiche? _____
To what extent are microfiche misfiled or lost?

Is filing generally a problem (timewise, etc.)? _____ If so, how?

E. MICROFICHE SYSTEM DESCRIPTION (continued)

28. Review questions 2. through 27. above. For each question, consider CLASSIFIED microfiche materials and note below how procedures differ, where applicable.

E. MICROFICHE SYSTEM DESCRIPTION (continued)

29. Approximately how many user requests for microfiche does the activity process monthly? If users have direct access to microfiche (self-serve style), estimate their "request" rate.
Staff processed requests _____. Self-serve "requests" _____. Total requests _____.

30. Of the above, approximately what percent are found in the activity's microfiche collection? _____%
What percent must be obtained from outside sources? _____% In each case, what is the average time consumed in satisfying the users request? _____

31. Approximately how many titles are ordered from outside sources each month?

	Hard copy specified	Microfiche Specified	Other media specified (list)	Media not specified
DDC				
Others				
Total				

32. Approximately how many original microfiche does activity generate internally each month, if any? _____ Other Microforms? _____

33. How many microfiche are received automatically from outside sources each month (such as from DDC's Automatic Distribution Program)?

DDC _____
Others _____
Total _____

E. MICROFICHE SYSTEM DESCRIPTION (continued)

34. What are total microfiche acquisitions in an average month (from all outside sources and internal generation of originals, if any)? (number ordered plus number received automatically plus number internally produced) _____

35. Does activity have a purge policy to periodically eliminate microfiche from storage? _____ If yes, discuss.

36. Again, if yes above, what is deletion rate in average month? _____

37. What is net growth rate of microfiche collection (acquisition rate minus deletion rate)? _____

38. Approximately how many microfiche are retrieved from storage each month for users? (Exclude "false-drops" from total. Where users have direct access to microfiche storage, estimate their retrieval rate. Staff retrievals _____. Self-service retrievals _____. Total retrievals _____.

39. Of the above total, how many are check-out on loan (one-day or longer) per month? _____ How many microfiche are out on loan today? _____

40. What percent of the microfiche collection is active (regularly requested by users)? _____ What percent is relatively inactive (rarely or never requested by users)? _____. Discuss.

E. MICROFICHE SYSTEM DESCRIPTION (continued)

41. What is size of microfiche collection?

CLASSIFIED documents _____

UNCLASSIFIED documents _____

Total microfiche _____

42. What is the capacity of the microfiche storage device(s)?

CLASSIFIED storage unit capacity _____ Number of units _____ Total capacity _____

UNCLASSIFIED storage unit capacity_____ Number of units _____ Total capacity _____

43. Are activity-owned readers and/or reader-printers located at remote locations for the convenience of individual users? _____

If yes, what and how much equipment is at each remote station? _____

E. MICROFICHE SYSTEM DESCRIPTION (continued)

44. Estimate the use-rate (hours per week and users per week) of readers (exclude reader-printers).

(For location, enter "local" or "remote." For user category, enter "staff," "customers" or "both.")

Reader	#1	#2	#3	#4	#5	#6
Location						
User category						
Hours per week						
Users per week						

45. Estimate the use-rate (hours, users and prints per week) of reader-printers. (For location, enter "local" or "remote." For user categories, enter "staff," "customer" or "both."

Reader-printer	#1	#2	#3	#4	#5	#6
Location						
User category						
Hours per week						
Users per week						
Prints per week						

E. MICROFICHE SYSTEM DESCRIPTION (continued)

46. Does the activity have a printing capability (microform to hard copy) other than the reader-printers shown above (e.g., volume reproduction equipment)? _____ If yes, explain. Estimate volume.

47. If No to question 44, does activity have a requirement for volume reproduction (microform to hard copy) beyond the practical capability of reader-printers? _____ If yes, explain.

48. What is the requirement for making hard copy from microfiche? Discuss frequency of user requests. Do users request reproduction of single (or few) pages or entire documents?

F. USER PREFERENCES

1. Based on experience so far with microfiche is the activity satisifed with that media as a part of its collection?

Very dissatisfied _____ Why?

Dissatisfied _____

Neutral _____

Mildly enthusiastic _____

Enthusiastic _____

2. In terms of convenience and cost, which is preferred, microfiche or hard copy?

	Microfiche	Hard copy
Staff Convenience	_____	_____
User Convenience	_____	_____
Overall Cost	_____	_____

F. USER PREFERENCES (continued)

3. Disregarding any actual plans for the future, what additional microfiche equipment or materials does the activity think it ought to have now? Why?

In 2 years? Why?

In 5 years? Why?

4. Assuming that the present microfiche handling system was non-existent, how would staff personnel design a completely new microfiche system? What would the minimum capabilities of the new system be (services provided, storage capacity, display methods, etc.)?

5. Could the activity use a complete set of AD document abstracts on microforms? (Abstracts of approximately 600,000 documents increasing at the rate of about 50,000 per year.) Explain.

6. If yes to 5. above, how many back-years would the activity need? Last year? _____ Last 2 years?_____ Last 3 years? _____ Last 4 years? _____ More? (specify) _____

F. USER PREFERENCES (continued)

6. What does the activity like/dislike about DDC services? In what ways could DDC improve its services?

7. Would the use-rate of microfiche change if microfiche were distributed free by the activity rather than loaned to users? _____ Which would be more costly to the activity? _____ Why?

8. Has the activity's experience so far with microfiche revealed any "lessons learned"? Have any systems or procedures been tried which have been significantly successful or unsuccessful? Discuss.

POST-INTERVIEW CHECKLIST

1. Sketch floor plan

2. Construct microfiche system flow-chart

3. Analyze microfiche equipment performance characteristics.

4. Review questionnaire for omissions

5. Verify 2. and 3. with activity staff

6. If available, interview individual user(s)

APPENDIX C

This appendix contains a copy of the Interview Guide which was used during the data collection phase of the study. The Interview Guide was employed during surveys of some of the smaller users, where microfiche operations were too modest to warrant the use of the comprehensive Survey Questionnaire.

INTERVIEW GUIDE	GENERAL
Activity Surveyed:	
Date:	
Personnel Interviewed:	
Organizational Structure:	
General Description (type activity, size, specification, user types and numbers, floor plan, staff size, etc.):	

INTERVIEW GUIDE (CONT')	COLLECTION

Microfiche Collection (size, composition, sources, amount of duplication in other media, classification, etc.):

Other Microforms (number, composition, sources, duplication in other media, usage, etc.):

INTERVIEW GUIDE (CONT') EQUIPMENT

Microfiche Storage Equipment (description, capacity, percent filled, location, order of contents):

Readers and Reader-Printers (for each: name and model number, location, by whom used, rate of use, good features, bad features, etc.):

Total readers: ☐

Total reader-printers: ☐

Other Equipment (description, rate of use, etc.):

INTERVIEW GUIDE (CONT') INDEX/CATALOG

Microfiche Index or Catalog (physical description, location; if locally prepared, what type indexes, what items in entries, abstracts, what order; if part of master catalog, what annotation for microfiche; if subject index is included, describe, what thesaurus, if any; etc.):

INTERVIEW GUIDE	PROCEDURES

Input Function (Step by step procedure from time new microfiche is received until it is ready for storage. Classifying and/or coding. Catalog procedure. Abstract preparation. Preparation of catalog cards. Marking or notching microfiche. Is cataloging before or after distribution to requestor, if any? Who is responsible? Estimated number of microfiche acquired by activity per week.):

Microfiche acquired per week ☐

Storage Function (Procedure, order of microfiche in storage container, etc.):

Announcement Function (Description):

INTERVIEW GUIDE (CONT') PROCEDURES (CONT')

Search Function (Step by step procedure from time of user request until identity and location of desired document is determined.):

Retrieval Function (Procedure for locating and extracting desired microfiche from storage. Estimated number of microfiche retrieved per day. Etc.):

Microfiche retrieved per day: ☐

Delivery Function (Procedure for transporting microfiche from storage area to requestor. Not applicable, if requestor performs retrieval function. Average time lapse from request to delivery vs usual urgency of user requests, including occasions when document must be ordered from supplier. Etc.):

INTERVIEW GUIDE (CONT') PROCEDURES (CONT')

Viewing Function (Availability/distribution of equipment. Viewing done at activity vs away from activity. Rate of use of activity's reading equipment in hours per day. Etc.):

Total read hours per day: ☐

Reproduction Function (Availability/distribution of equipment. Rate of use in pages (excluding whole docs) per day. Reproduction of whole documents, if any. How done, by whom. Etc.):

Total prints per day: ☐ Whole docs per __: ☐

Refiling Function (Procedure, Problems, Etc.):

INTERVIEW GUIDE (CONT') GROWTH/PLANS

Past Growth (Growth rate of total collection in recent years. Year microfiche collection started and growth since. Growth factors. Reasons for ordering microfiche then and now. Etc.):

Anticipated Future Growth (Will growth rate increase, decrease or remain steady? Why? Estimated size of microfiche collection in 1972 and 1975. Etc.):

Collection size in 1972 [ ] 1975 [ ]

Plans (Firm plans, if any, related to future microfiche usage. Plans for accommodating future growth, with and without increases in floow-space. Etc.):

INTERVIEW GUIDE (CONT')	PREFERENCES
Microfiche vs Hard Copy (Circumstances under which user prefers microfiche over hard copy. Hard copy over microfiche. Record only unprompted response of user in this block.)	
Continuation of above: If user requires prompting, suggest following considerations, as appropriate: Customer convenience, ease of use, acceptance, etc. Ease of processing, handling, filing Initial Costs Long-term costs Storage (high-activity documents, low-activity documents, archival documents) Other considerations, specify:	
Microfiche vs Other Microforms (Experience. Reasons.)	
Negative vs Positive Images (Experience with each. Preference. Reasons.)	

INTERVIEW GUIDE (CONT')	BEST SYSTEM

Best System to Fit Present and Near-future Needs (User comment on what type storage and retrieval device would best fit his and his customers' needs. Auto or manual. What features. Capacity and speed. Is a "shoe box" good enough? What specific off-the-shelf devices has he seen and liked?)

(User Comment on what type viewing device(s) would best fit his and his customers' needs. Type display. What features. What interface with storage and retrieval system? Size, portability. Numbers. What specific off-the-shelf devices has he seen and liked? Is his present equipment satisfactory?)

(User comments on other equipment or procedures to provide a total microfiche handling system to best fit his and his customers' needs.)

How much of above can activity afford? Could a $3 - 4,000 investment in a basic, semi-automated system be justified?

INTERVIEW GUIDE (CONT')

Misc. Notes.

APPENDIX D

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10. DISTRIBUTION STATEMENT

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
None.	Defense Documentation Center Defense Supply Agency Cameron Station, Virginia

13. ABSTRACT

Report of a study of the microfiche storage and retrieval equipment requirements of a group of small DoD facilities. The report contains a survey of small user requirements, a market estimate, surveys of the state-of-the-art and current research in microfiche storage and retrieval technology, and design specifications for storage and retrieval equipment recommended for small microfiche users.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Current Research						
DDC						
Equipment Design						
Equipment Specifications						
Information Centers						
Information Retrieval						
Libraries						
Market Survey						
Microfiche						
Microfiche Systems						
Microfilm						
Microforms						
Micromation						
Reader-printers						
Readers						
Reprography						
Retrieval						
State-of-the-Art						
Storage						
System Design						
User Requirements						
User Surveys						